COLONY AND PROTECTORATE OF KENYA

DEPARTMENT OF AGRICULTURE
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DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
1961

Volume II—Record of Investigations

CONTENTS

	Page
Introduction by Chief Research Officer	1
Annual Report for 1961 of the Officer responsible for research Work on—	
Entomology	4
Plant Pathology	14
Soil Chemistry	20
Plant Breeding	43
Plant Pathology (Plant Breeding)	55
Coffee—	
Coffee Services, General	58
Entomology	60
Agronomy Investigations	63
Coffee Liaison (African Districts)	66
Plant Pathology	67
Plant Physiology	69
Agricultural Chemistry	71
Grassland Research	74
Horticulture	95
Pyrethrum	107
Sisal	110
Irrigation Investigations	118
General Husbandry—	
Central Province	124
Rift Valley Province	129
Nyanza Province (Northern)	135
Nyanza Province (Southern)	144
Southern Province	152
Coast Province	158

CORRIGENDA

ANNUAL REPORT, 1960, VOL. II

Alternative crops, p. 108 l. 1.

Amend "Six *sunflower* varieties . . ." to read "Six *Safflower* varieties".

ANNUAL REPORT, 1961, VOL. I

TABLE D.—Castor Seed, Southern Province: *for* 933 bags *read* 14,165 bags.

Onions

Central Province—quantity should *read* .. 196 bags

Totals—quantity should *read* .. .. 307 bags

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INTRODUCTION

Comments on the unusual weather of 1961 are found in all reports which comprise this volume. It was a year of both drought and deluge. The general pattern was made up of an exceptionally dry first half and a second half which established new rainfall records for Kenya. The months of October and November were particularly wet and caused many upsets to research work, part of the heavy damage inflicted on the whole country. Many trials failed, and much of the research conducted under such atypical conditions has produced results which must be accepted with reservations.

Infestations of armyworm appeared in severe form. Research Division staff were engaged in the general control of these outbreaks which are described in the report of the Senior Entomologist. At the same time, although control measures were applied as soon as possible, the infestation did result in damage to a number of field trials.

On the other side of the picture it is a pleasure to record that, despite general financial stringency, the Department has been able to sustain its research effort at the normal level. Financial support from the agricultural industry itself has continued to make a vital contribution as has also generous aid from Colonial Development and Welfare funds, the Rockefeller Foundation, and the Agency for International Development of the U.S.A.

In all, despite the difficulties of the year, a good deal of progress in research has been achieved, and it may be of value to mention some of the more interest ing features of the year's work in this foreword.

Mention has already been made of the outbreaks of armyworm. A wide range of control methods had to be called into service in dealing with the outbreaks. Aerial spraying was a great help in the campaign. Also of interest was the isolation of a polyhedral virus causing disease in the armyworms and its subsequent use as a spray to infect small caterpillars.

The report of the Senior Soil Chemist refers to the work undertaken by Dr. Mehlich on the chemical characterization of clay minerals and the mechanism of retention and release of the major plant nutrients. This study is leading to field trials with various fertilizer treatments in 1962, and it promises results of considerable practical value to agriculture in Kenya. The chemistry report also includes a summary to date of certain long-term liming trials laid down in situations where it was considered that liming treatments would be most likely to produce worthwhile results. This summary puts the likely benefits from liming in these situations into perspective. The lime-phosphorus interaction revealed in these liming trials is of considerable interest. A notable achievement by the Soil Chemistry Section was the publication during the year of an advisory bulletin entitled "A Guide to Fertilizer Use in Kenya".

Major items on the programme on the Senior Plant Pathologist have concerned such important diseases as bacterial wilt of potatoes and sugar cane smut. "Blast", a disease of onions caused by *Botrytis allii*, was recognized in July for the first time in Kenya and turned out to be a serious disease of this crop. The plant pathology team has been strengthened by the arrival of Dr. Hollis, a Fulbright Scholar, who has initiated nematode surveys and field trials of soil fumigants on a number of the more important crops. The need for such research

has been recognized by the Department for some time. At the end of the year Dr. J. J. Njeroge, after acquiring his Ph.D. in the United Kingdom, arrived to join the plant pathology team. He is thus one of the first of a number of Africans in training to take up a senior post in the Research Division.

The work of the plant breeders on cereal crops suffered perhaps more from the unusual weather of 1961 than that of most research workers. Due to the prolonged drought the incidence of rust was exceptionally low; when the heavy rains came later the small grained cereals suffered severely. In addition a new rust form made its appearance, attacking wheats based on *Triticum timopheevi*, a type of resistance which was effective against all the known races and to which considerable attention had been paid in the breeding programme. However, the plant breeding report records much progress, not the least important matter being the expansion of the testing of international collections of wheat for rust resistance made possible by a Rockefeller Foundation award. In the maize breeding programme Kitale Synthetic II is continuing to prove itself a superior type in the high yielding maize areas and the programme is producing further types which promise well.

The substantial research programme on coffee continued smoothly in 1961 with progress on all fronts. An interesting point to arise was the rather spectacular response to soil fumigation in the coffee nursery at the main station. The seedings showed very substantial improvement in growth, with spectacular growth of the tap root and a change in the whole root system.

A considerable effort has been put into research on the minor element nutrition of pastures in the programme of the Grassland Research Team. After several years this work has reached a stage where sufficient results are available to put the problem into perspective. Although fuller reports will be published separately, the present summary gives a good picture of the level of increase of production that can be achieved in the particular areas in which the trials have been undertaken. The Pasture Chemist's report gives more detailed results of plant composition as it occurs, either at a specified stage of growth or at different stages of growth. The relationships between composition and maturation which he derives from the data are of considerable interest.

The main work of the Horticultural Section has been devoted to pineapples and has concerned extension almost as much as research. The recommendations stemming from previous research have been very largely adopted in the new pineapple growing areas, but the older areas, which are also still the main ones, have adopted the recommendations to a limited extent only. The research into the vegetative propagation of Macadamia nuts should lead to substantial improvement in this minor, but, in the long term, potentially important crop. Progress with the new crop, Dioscorea, has continued. The pace of development has been set by the availability and rate of multiplication of planting material of suitable species rather than by anything else.

The arrival of a Plant Breeder to join the Pyrethrum Station staff at Molo has enabled important work on the improvement of the pyrethrum crop to be initiated, including a new line of polycross breeding.

At the High Level Sisal Research Station preliminary studies have been undertaken with a view to the initiation of a plant breeding programme. This is a new venture for the station. Another aspect of sisal research which is of particular interest is the investigation of the trace element nutrition of the crop which is being undertaken at the Scott Laboratories and to which reference is made in the Senior Soil Chemist's report.

Work on a wide range of problems has continued on the general research stations in the Provinces. Special mention is made here of the field trials on crop and soil moisture relationships at Katumani Experimental Farm. The results of the first cycles of these trials are summarized in the report of the Agricultural Officer (Research), Southern Province, and the soil physics aspect is referred to by Dr. Evans in the report of the Senior Soil Chemist. Another encouraging feature of the general research programme has been the progress made in assessing the seasonal productivity and feeding value of pasture and fodder crops throughout the year.

The Intelligence Unit set up at the Scott Laboratories in 1961 to deal with crop introduction, including co-operation with research stations in the field testing of new crops, and to maintain the central records of the Research Division, has settled into a successful system of operation and is proving itself to be a worthwhile innovation. The statistician has also been associated with this unit.

It remains to thank all those concerned in the work of agricultural research for the effort they have sustained throughout a difficult year.

E. HAINSWORTH,
Chief Research Officer.

ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST

Entomologists were stationed at Kibos (Nyanza Province), Nakuru (Rift Valley Province), Mtwapa (Coast Province) and Kilindini. Stored products work, Coccid Taxonomy and Plant Protection were carried out at the Scott Agricultural Laboratories.

Plant Protection Services

Only minor alterations were made to the rules by the Standing Technical Committee for Plant Imports and Exports. A booklet entitled "A Guide to the Regulations Governing the Import and Export of Plant Material to and from East African Territories" was published and distributed to all known Kenya importers and to District Agricultural Officers. Copies were also sent to exporters who send planting material to Kenya. The booklet provides an explanatory guide to the Plant Protection Rules and shows the plant and plant parts which are subject to special conditions. An importer can now ascertain from what countries (if any) he can import planting material.

An overall fall in the imports and exports subject to Plant Protection Rules was recorded. Thus parcels inspected through the Post Office totalled 834 as against 1,039 in 1960 while airfreight consignments totalled 195 as against 233 for 1960. Importation permits fell from 1,282 in 1960 to 1,246 in 1961. Phytosanitary certificates issued in respect of export consignments were 49 less than the previous year's figure of 318.

One methyl bromide and 26 hydrogen cyanide fumigations were carried out.

A coccid, *Parlatoria blanchardii,* was intercepted on orchids from United States of America.

The co-operation of the Staff of Customs and Excise, General Post Office and the East African Airways Corporation is again recorded with pleasure.

Stored Products Work

One meeting of the Pest Infestation of Stored Products Committee was held in 1961.

Mr. Kockum, Scientific Officer of the Maize Marketing Board reports as follows:—

The year was exceptional with food shortage, delayed harvesting and transport difficulties due to heavy rain. As a result a more rapid turnover of stocks occurred and the forced intake of maize with a relatively high moisture content led to problems of moulding rather than of insect infestation.

Cool grain moved from a cold area into a warm one leads to rapid absorption of moisture and growth of mould may occur before the grain warms up and moisture content falls. A whole shipload of famine relief maize coming from Philadelphia U.S.A. to Mombasa was found to have deteriorated on arrival due to this cause; similarly, maize moved from the highlands to low altitude stores may become mouldy if not well dried. While slow moisture translocation from hot spots generated in bulk grain is well known this more rapid rise of moisture content needs investigation.

Since the change in formulation of Blue Cross Powder, for admixture with grain and legumes, from 0.04 per cent lindane to 0.7 per cent malathion there has been a complaint of a heavy infestation of *Acanthoscelides obtectus* in a consignment of beans from Central Province to Mombasa. Living beetles were

obtained by dissecting these beans and were placed in equal proportions in jars containing the original dusted beans and beans washed with tap water. Within 24 hours the former had all died while the latter all survived. It would thus appear that the beans had been dusted after a heavy infestation and that malathion, lacking fumigant action, killed the emerging beetles by contact. These had been seen crawling before being killed and give the impression that the dust was ineffective. With the lindane dust the Bruchid usually dies before emerging from the bean.

A large scale maize crib experiment was set up in February in co-operation with the Pyrethrum Board of Kenya to test three formulations of pyrethrum dust. Two formulations of lindane and a control of untreated cob maize were included. Each treatment consisted of 243 cubic feet of cob maize and was replicated four times.

Shelling began after seven months of storage. The infestation of maize weevil was late and of low intensity while the population of secondary insects was also much lower than in previous experiments. The main pest was *Sitotroga cerealella,* the attack beginning in untreated maize at one end of a crib and being followed by a rapid increase of the two parasites of *Sitotroga, Anisopteromalus* and *Nemeritis. Sitotroga* spread to the remaining parts of the crib but was partly controlled by its parasites. This resulted in a great range in the percentage of damaged grain in the replicated treatments after shelling.

Statistical analysis of the percentage damaged grain from pre-arranged sampling points showed that all the insecticide treatments used had given almost complete protection in the body of the crib but on the top and sides, to a depth of one foot, the cobs were completely unprotected from *Sitotroga* attack by all the pyrethrum formulations. Lindane gave good protection: the old formulation of 0.5 per cent in diatomite at 8 ounces to 9 cubic feet was not quite as good as the 1 per cent at the same rate against moth infestation.

One of the pyrethrin formulations was specially made up by the Pyrethrum Board's Laboratory to compete in price with the lindane formulations. This gave good protection within the crib but not on the exposed sides where the formulation broke down. Further work is necessary to overcome this difficulty.

The wasp, *Microbracon hebitor,* was found in three widely separated stores in Nairobi towards the end of the year. This cosmopolitan parasite of several storage pests has never before been recorded in East Africa.

Work began on a cheap mechanical device for use in stores and markets for the better admixing of insecticide and produce.

Mr. Ashman reports from Kilindini as follows:—

Inspection of areas in Kenya where entry of *Trogoderma granarium* might occur continued and Kwale, Vanga, Kinango, Lamu, Taveta, Kilifi and Mombasa were visited and found free of this pest.

Two technical assistants have been trained in inspection techniques and carry out routine searches at Kisumu and Mombasa. At Kisumu work was confined mainly to the inspection of produce carried on the lake steamers. A visit to Tanganyika was made and *Trogoderma* could not be found in stores at Moshi, Dodoma and Morogoro.

During the year *Trogoderma* was intercepted on many occasions in produce from India, Pakistan, the Persian Gulf and Tanganyika.

Large stocks of maize were imported from Rhodesia and South Africa during the year for famine relief. All the Rhodesian maize was fumigated on arrival with methyl bromide at the rate of 3 lb./1,000 cubic feet for 24 hours under gasproof sheets. All trucks used for temporary storage and the stack surfaces of the temporary stacks were sprayed with 100 mgs. per square foot of malathion using motorized knapsack sprayers. The South African maize was subjected to a strict inspection for *Trogoderma* using a sack sieve capable of handling a full bag at a time. Sacks from different levels of the ships holds were sieved, some 203 bags from a total of 100,000 being examined. Using two sack sieves a statistically acceptable sample could be examined in a practical manner. No maize from either South Africa or Rhodesia was observed to be infested with *Trogoderma granarium.*

Two polywood silos are now in use at Mtwapa Agricultural Research Station, each holding 20 tons of grain. Locally grown maize or sorghum was successfully stored after treatment with 0.7 per cent malathion on the basis of 4 oz. to 200 lb. of grain.

Reported failures of malathion dust at eight parts per million to control *Sitophilus zea mais* were investigated and it was found that the grain had been damp when the treatment had been carried out.

The Infestation Control Division of the Ministry of Agriculture, Fisheries and Food, have reported an increase in insect infestation in certain produce passing through Mombasa but investigation showed that such produce, consisting largely of oilseed cakes, was not of Kenya origin.

In a pyrethrum trial employing a Swing-fog misting machine good results were obtained against flying adult *Ephestia cautella* and *Tribolium* and further work is proposed.

Routine wheat store inspections continued and conditions have improved; new recommendations have been introduced and are giving excellent results. All stacks are treated layer by layer with lindane or malathion dusts. Malathion 2 per cent dust has replaced lindane 1 per cent dust for external bag treatments in stacks at Nairobi and Eldoret where higher temperatures are encountered. Lindane continues to be used successfully at Naivasha, Ol Kalou and Thomsons Falls.

A new *Scenopinid* (Diptera) predator has been found in large numbers on the outer surface of bags of bran heavily infested with *Tribolium castaneum* and *Ephestia cautella* and is recorded for the first time in Kenya.

Field Pests

The most serious field pest of the year was undoubtedly armyworm, *Spodoptera exempta.*

This pest normally shows a two-year periodicity in its outbreaks and an infestation was expected in January, 1961. A broadcast warning was issued but the armyworm failed to appear and reports from Arusha confirmed its absence from there also.

A heavy infestation did, however, arrive in South Western Kenya at the end of March and spread northwards into Uasin Gishu and Trans Nzoia in April. An easterly arm of the outbreak affected the Nakuru area, Subukia, Ol Arabel and Thomsons Falls and finally spread to Nanyuki and the Nyeri area where it died out in early June. In the meantime, an infestation moved northwards from Northern Province, Tanganyika, into Kenya's Southern Province affecting the Kamba country and Lower Rift.

The outbreak followed a drought of unusual severity and the armyworm invaded areas where it normally does not occur. A ceiling of 6,500 ft. is usual in most outbreaks, with larvae occasionally occurring at 7,000 ft. In 1961 they occurred at 8,300 ft. and thus were able to attack cereals over a wider area than usual. This was particularly the case on the Uasin Gishu plateau. This spread to higher areas is believed to be due to the higher temperatures which occurred at high altitudes and which were associated with drought conditions.

Because of the drought armyworm damage to grazing was severe. Some new growth was so badly damaged that certain grasses disappeared from the pasture leaving sedges and weeds standing out from bare and brown sward. Reserves of hay and silage were often quite inadequate and movement of cattle into unaffected areas was necessary. Despite this heavy mortality of cattle occurred and milk production was seriously affected.

In the cereal growing areas the attack coincided with early growth of maize and spraying of insecticide was employed to reduce the damage. The standard recommendation of 3 pints of 25 per cent D.D.T. proved satisfactory but supplies soon ran out and where small caterpillars were involved the recommendation was reduced to 2 pints per acre. Similarly the quantity of 18 per cent dieldrin emulsifiable concentrate, recommended at 1½ pints was reduced to 1 pint while for 19.5 per cent endrin the corresponding figures were ¾ pint and ½ pint. Aldrin at 1½-2 pints per acre of the emulsifiable concentrate (24 per cent) was less satisfactory as was B.H.C. 20 per cent concentrate at 1 pint per acre.

Chlordane and toxaphene were used successfully, the former at 1 pound to 1¾ pounds per acre active ingredient while 75 per cent toxaphene, a cattle dip formulation, was effective at 1½ pints per acre. The use of various cattle dips by farmers was necessitated by the shortage of insecticide which was alleviated by the arrival of supplies of D.D.T. by air.

Other materials used were diazinon 60 per cent at ½ pint per acre, malathion 50 per cent at 1½ pints per acre, Dipterex at 5 oz. per acre 80 per cent wettable powder and pyrethrum dust. The above materials gave a satisfactory kill but lacked persistency.

The use of aerial spraying speeded up control operations and undoubtedly saved some maize from total loss. The aircraft of Desert Locust Control deserves special mention as they were able to give additional help at a time when all the commercial aircraft were already fully occupied on armyworm control. The lower application rates of these aircraft also enabled larger acreages to be sprayed per day.

Early in the campaign caterpillars at Koru were found to be dying and the entomologist from Kibos was able to collect a quantity of them and to forward them to Nairobi. These were found to contain a polyhedral virus disease and extracts were made from it and sprayed in the Nakuru area. Results were at first disappointing until it was realized that the caterpillars being sprayed were too big: these pupated before the virus became effective. Where small caterpillars were sprayed virus symptoms appeared eight to twelve days later and gave a good kill. There was of course no proof that such virus did not already exist in such places. Evidence, however, did show that all sprayings of small caterpillars did result in deaths from virus.

Interested farmers attempted to make us supplies of virus for their own use, sometimes successfully but uninfected caterpillars seem to have been used to some extent and weak dilutions resulted.

A second but much less severe infestation of armyworm occurred in November spreading northwards to affect Machakos, Kitui, Isiolo, Nairobi, Kedong, Naivasha, Nakuru, Rumuruti, Fort Ternan and Kericho.

Virus was sprayed as soon as the first infestation was reported and a response was found about ten days later. In this case the kill can be directly attributed to the virus sprayed artificially since virus would not occur in a natural state at the beginning of an outbreak in such a concentration. This second infestation enabled us to build up stocks of virus at the laboratories though much of it replaced stocks issued to farmers. Current stocks are believed to be adequate to spray 10 square miles of grassland.

Virus can be prepared as follows and the crude technique can be carried out by farmers without special equipment. Infected caterpillars climb to the tops of grasses or weeds before dying. The green undersurface of their bodies becomes bright yellow. The body contents liquefy and burst through the body wall. This liquid is foul smelling and is greyish yellow in colour. Where the disease is well advanced many caterpillars burst and their contents are lost while collecting, so it is more convenient to collect those which are still alive though obviously sick. These can be left in a container for two or three days, kept moist by a little water and covered to prevent the entry of blowflies. The rotting mass is then squeezed through muslin and the liquid obtained should be carefully stored in a cold place until required for spraying. If a high concentration has resulted as little as a teaspoonful of virus can be diluted in two or more gallons of water to cover an acre in a low volume sprayer. If sprayed discontinuously it can be distributed adequately over an acre to infect the caterpillars. If applied to small caterpillars, a further supply of virus should be ready for collection about ten days later, thus allowing a supply to be bulked up. Most of the virus, of course, is spilt on to the vegetation and it may remain there if conditions are suitable for several months, if not years.

While it is slow in action and therefore useless for the protection of crops it should, however, be of value in protecting grassland in future outbreaks.

The second outbreak was partly controlled by virus but other natural controls were at work. The *Eulophid, Euplectrus laphygmae,* occurred abundantly as also did a species of *Ecphoropsis*: both are recorded from this host for the first time. Tachinid parasites included *Isomera cinerascens, Drino zonata, Actia sororcula* and a species of *Wagneria.* The two latter species are new records for East Africa. In addition some caterpillars were parasitized by Nematodes and bacterial and fungal diseases also took a toll.

Work in Coast Province

Mr. E. A. S. La Croix reports as follows from the Coast Province:—

In a comparison of miticides applied against the cotton red spider mite (*Tetranychus telarius* complex) it was found that Metasystox and Rogor were highly significantly superior to Kelthane and a Tedion/malathion mixture which, in turn, were highly significantly superior to P.P. 175. All treatments showed mite populations highly significantly lower than in unsprayed cotton.

Two applications separated by a 12 day interval were used, but an interval of eight days is more certain to be effective in view of the length of the life cycle of the mite in costal conditions. No marked build up of aphis occurred on the treated plots though significantly lower populations occurred on the cotton sprayed with P.P. 175. In other trials it has been found that mites build up in cotton dusted with B.H.C./D.D.T. dusts and sprays, but not under dusts and sprays of Sevin or toxaphene or under endrin sprays.

The very heavy rainfall affected cotton experiments adversely by washing off some of the insecticide and by damaging the open bolls. Picking did not come to an end until December and only three or four picks could be made in each experiment. As might be expected yield differences between experimental treatments did not differ significantly.

In an attempt to find alternatives for cotton dust various sprays were compared with the standard rate of six applications of 12 lb. of 3 per cent gamma B.H.C./5 per cent D.D.T. dust. Endrin, at five applications of 16 oz. per acre in ten gallons of water, gave the best yield of 1,091 lb. per acre of which 77.5 per cent was "A.R." grade. The standard dust treatment differed but slightly from sprays of (1) B H.C./D.D.T. at 5 oz. B.H.C./8 oz. in ten gallons of water applied six times, (2) Sevin and (3) toxaphene, both at 16 oz. in ten gallons of water, applied six times, the yields being between 920-940 lb. per acre. A Sevin dust (10 per cent) yielded 892 lb. of cotton (82.1 per cent A.R.) while 10 per cent toxaphene dust yielded 820 lb. (76.7 per cent A.R.). Both were applied six times at 12 lb. per acre. All treatments controlled stainer bugs, with endrin giving outstanding control. Satisfactory control of aphis was achieved by B.H.C./D.D.T. and endrin but not by dusts or sprays of Sevin or toxaphene. An increase of Jassids occurred with the 3:5:0 (B.H.C./D.D.T.) standard cotton dust: the best control occurred with the use of endrin. Attack by American and spiny bollworm was extremely light and no significant results were obtained.

An extended interval experiment was undertaken at Mtwapa comparing endrin, Sevin and toxaphene sprays at four three-weekly applications (all at 16 oz. active ingredient in ten gallons of water per acre), with endrin at five two-weekly sprays and with Sevin and toxaphene at six two-weekly sprays. Spraying at four three-weekly intervals gave a mean yield of 656.4 lb. per acre, 68.6 per cent A.R. grade, and an income of Sh. 287 per acre. The two-weekly interval treatments gave a mean yield of 991 lb. per acre, 79.6 per cent A.R. grade, and an income of Sh. 475 per acre. This difference is highly significant and indicates that attempts to increase the spraying intervals or to reduce the number of sprayings are inadvisable in coast conditions.

In an experiment to assess the economic damage done by pests at different periods of the season no differences in yield could be detected.

In an assessment trial at Mtwapa, cotton which had been sprayed weekly (13 times) in order to control all insect pests from flowering to first picking produced 1,987 lb. per acre compared to 1,017 lb. per acre for unsprayed cotton, an increase of crop value of Sh. 485 per acre.

Damage from American and spiny bollworm was especially heavy in the Tana River area. Pink bollworm was widespread this year through the Coast Province and was more easily found than in the previous year. No diapausing larvae of pink bollworm were found.

Work on the identification and importance of the wild hosts of cotton stainers continued. The first dispersal from the wild hosts occurred after the first heavy rain in June.

In a trial at Mtwapa control of maize stem borer, *Chilo zonellus*, by two sprays of 0.1 per cent D.D.T. or by two dustings each of 25 lb. of 2 per cent D.D.T. applied overall, increased yields by 39.7 per cent or 633 lb. per acre.

The first invasion of maize by stem borers occurred in May with the peak population in early June in April-sown maize. Within the temperature range of 22.6° C. minimum to 29.2° C. maximum the following figures for the life cycle of *Chilo zonellus* were ascertained: — Egg 5-7 days, larva 16-20 days, pupa 6-7 days.

In mangoes double applications of D.D.T./malathion sprays to the growing points of mangoes had no influence on the development of flowering shoots.

Work in Nyanza Province

Mr. Davidson reports as follows:—

The principal entomological work in Nyanza Province was carried out on cotton. Results will be reported in detail in the Empire Cotton Growing Corporation's Annual Report.

Populations of most species of cotton pests at Kibos were affected by both the drought of June-August and by the abnormally heavy rains of October-December. In the March-May rains the incidence of most pests was fairly normal. Stainers began to breed on wild Malvales in early March, increased to a maximum in mid-April and decreased to nil in late May. These fluctuations were found to correspond to the numbers of fruit available on the preferred host species. During this period *Dysdercus nigrofasciatus* formed 50-60 per cent of the total stainer population, and *D. superstitiosus* the remainder. Spiny bollworm also bred on wild Malvales, especially *Abutilon* spp., in March-May, and then moved into March-sown cotton, along with American bollworm. Bud damage by these early bollworms occurred mainly from late May to June, that is, corresponding to maximum flowering of the cotton crop. *Lygus* also invaded cotton from mid-May to early June but did relatively little damage.

From mid-May to the end of August less than 7 in. of rain fell at Kibos. During this period the numbers of most pests were lower than usual. Stainers resumed feeding on wild Malvales in late June, and began to move into the cotton crop at the same time, but did not attain large numbers in the initial immigration. *D. nigrofasciatus* continued to form the majority of the total stainer population. There was no evidence of stainers feeding and breeding in the sorghum crop, as had been observed in previous years. Damage from early bollworms dwindled in June, but cotton which did not receive insecticide protection during this period was prevented by water stress from replacing the fruiting points destroyed by bollworm attack. Cotton which did not receive insecticide protection in July suffered little loss in total yield but an increase in the proportion of stained cotton due to damage by stainers. There was a severe attack of aphids in June, July and early August, as would be expected in such dry conditions.

In September cotton began to flower again and produced young bolls. However, from the middle of October to the end of December over 30 in. of rain fell. Skies were overcast and humidity was high. As a result, the ripe green bolls failed to dry out and open, but were subjected to the attacks of spiny bollworm and the late bollworms, pink bollworm and false codling moth. Stainer populations also increased greatly, and included large numbers of the normally rarer species *D. fasciatus* and *D. cardinalis*. The damage caused by these pests was augmented by rots spreading from the insect lesions within the rain-sodden bolls. The second flush of crop, which might otherwise have compensated for the losses of the June-July drought, was thus severely damaged and largely destroyed.

In insecticide trials at Kibos and Homa Bay, a dust containing 10 per cent Sevin was found to give significantly higher yields than both dust containing 3 per cent gamma B.H.C./5 per cent toxaphene and the standard cotton dust, 3 per cent gamma B.H.C./5 per cent D.D.T. At Kibos the Sevin dust gave yields as good as those given by spraying a B.H.C./D.D.T. mixture from motorized knapsack sprayers, a practice which has been found to give very effective pest control. In both trials yields were lower than average, due to the adverse weather conditions.

In an insecticide trial at Busia, Sevin sprayed at ½ lb. active ingredient per acre gave slightly but not significantly higher yields than D.D.T. at ½ lb. per acre and toxaphene at 1 lb. per acre. All three treatments gave significantly higher yields than an untreated control.

In trials on peasant farms in South Nyanza, the standard cotton dusting régime of seven applications at seven-day intervals was compared with seven applications at 14-day intervals, the latter treatment giving a more extended protection period of lower intensity. The 14-day interval treatment, gave poorer pest control and lower yields than the standard régime, although still much better than untreated controls. In a similar experiment in Elgon Nyanza, where D.D.T. was sprayed in six applications of ½ lb. active ingredient per acre per application, the 14-day interval treatment yielded about 90 lb. seed cotton per acre less than the standard régime, but still gave nearly 200 lb. per acre more than the untreated control.

In combined dusting and date of planting trials in Ukwala division, Central Nyanza, February planting gave greater yields than March planting if given insecticide protection. April planting gave much poorer yields than February or March, whether dusted or not. In Bondo division, nearer to the lake-shore than Ukwala, heavy rains in February and March caused waterlogging of plots planted in those months. April planting gave slightly better yields than March planting and both obtained an increase of about 200 lb. A.R. grade seed cotton per acre from the use of insecticide.

A trial at Senetwet, in the Lower Belgut region of Kericho District, was designed to determine the best period for insecticide application to March/April planted cotton in that area. No statistically significant differences were found but yield results indicate that protection from the 14th to the 20th week after planting was more effective than protection from the 10th to the 16th week. This result was rather unexpected and will require confirmation.

Dieldrin 50 per cent wettable powder was found to be an effective seed dressing against sorghum shoot fly on late planted crops. Sorghum sown on 20th March was only very slightly attacked by shoot fly and derived no benefit from seed dressings. Sorghum sown on 12th April, however, was severely attacked. Dieldrin 50 per cent wettable powder applied as dry seed dressing at rates of 1 lb., ½ lb. or ¼ lb. per 100 lb. of seed gave increases of over 200 lb. grain per acre over the untreated control.

A survey was carried out in March on passion fruit plantings on European and African farms in the Sotik-Kisii area, to investigate "woodiness" disease. The observations made during this survey lend support to the assumption that wind-borne insect vectors, such as aphids, are a major source of infestation of newly established plots. A Coreid bug, *Leptoglossus membranaceus* F., was found to feed on the fruit causing damage similar to the symptoms of the virus disease.

Observations on the insects attacking *Striga* showed that there was a lower incidence of the pests recorded in 1960. The major pest, the "Striga root-fly", has been provisionally identified as a new species, *Ophiomyia strigalis* Spence, but this identification cannot be confirmed until further material has been obtained.

Biological Control

Further liberations of the Cochincid, *Dactylopius indicus,* were made in the Coast Province. The species suffered a serious setback during the heavy rains of the later part of the year.

Seed fly of Lantana, *Ophiomyia lantanae* and the lacebug *Teleonemia scrupulosa* appeared to effect little control on Lantana. Further introductions are likely to be made when a substation of the Commonwealth Institute of Biological Control is set up in East Africa.

Systematic Study of Coccidae

Mr. G. de Lotto continued to work on the mealybugs from Africa South of the Sahara describing 20 new species.

Working in collaboration with Prof. W. S. Brown of the University of California he made a cytological study of some local mealybugs.

Identifications of Coccids from the neighbouring territories continued.

Publications

List of Publications

Bullock, J. A. *Nematocerus sp. (nr brevicornis)*: A pest of cereals in Kenya. *E. Afr. agric. For. J., XXVII*, p. 24.

———*Ibid*, p. 117.

———*Ibid*, p. 121.

Bullock, J. A. and Bond, D. C. Control of armyworm on grazing in Kenya. *Nature, 192*, p. 480.

Davidson, A. Empire Cotton Growing Corp., p. 7. Progress reports from Experimental Stations: Kenya. Entomology.

De Lotto, G. New Pseudococcidae (Homoptera Coccoidea) from Africa. *Bull. Brit. Mus. (N. H.) Ent. 10*, 209.

———A new *Stictococcus* species from Kenya (*Homopt. Coccidae*). *J. ent. Soc. S. Africa. 24*, 315.

———Two new Ceroplastes species from Africa (*Homopt. Coccidae*). *J. ent. Soc. S. Africa. 24*, 318.

Duncan, E. S. A Guide to the Regulations governing the Import and Export of Plant Material to and from East African Territories. Government Printer, Kenya.

Graham, J. F. Control of Armyworm by Virus. *Kenya Weekly News*, 12th May.

———Armyworm Outbreak. *Kenya Weekly News*, 22nd December.

Graham, W. M. Trapping Tribolium in Storage Experiments. *Trop. Agric. 39*, 53.

Graham, W. M. and Kockum, S. P. L. Admixture of Malathion and Lindane with Bagged Maize in Kenya. *Bull. ent. Res. 52*, 773.

La Croix, E. A. S. Observations on ecology of cotton flea bettles in the Sudan Gezira and the effect of sowing date on the level of population. *Bull. ent. Res. 52*, 727.

Wheatley, P. E. The Insect Pests of Agriculture in the Coast Province of Kenya. Part II: Cashew. *E. Afr. agric. For. J. 26,* 178.

———Part III: Sweet Potatoes. *Ibid,* p. 228.

———Part IV: Coconut. *Ibid, 27,* p. 33.

———Part V: Maize and Sorghum. *Ibid,* p. 105.

———Rearing *Pseudotheraptus wayi* (Brown) *Coceidae,* a pest of Coconuts in East Africa, and evaluation of its susceptibility to various insecticides. *Bull. ent. Res. 51,* 723.

Acknowledgements

The Commonwealth Institute of Entomology continued to assist with identifications, publications and advice and their help is gratefully recorded.

J. F. GRAHAM,
Senior Entomologist.

ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST

Staff

The section was severely handicapped for much of the year by staff shortages; of the five posts for plant pathologists, two were vacant and two more were temporarily vacant for about half the year while their incumbents were on leave and study tours. However, by the end of the year all five posts were filled and the section was fully staffed for the first time in four years.

Study Tours

From February to July, R. A. Robinson, Acting Senior Plant Pathologist, visited laboratories in India, Australia, New Zealand, Fiji, Hawaii, U.S.A., Holland and the United Kingdom. The main object of this study tour was concerned with legume bacteriology, but problems associated with sugar-cane, bacterial wilt of potatoes, woodiness disease of passion fruit and the production and certification of seed potatoes were also included. Funds were provided by the Kenya Government, the International Co-operation Administration and the Netherlands Government and are gratefully acknowledged.

Dr. E. J. Guthrie, Cereals Pathologist, was awarded a grant from the Rockefeller Foundation which enabled him to visit laboratories specializing in wheat rust work in Mexico, the U.S.A. and Canada.

Advisory Laboratory

The drought which prevailed over Kenya for the first 10 months of the year generally resulted in low incidence of disease. The subsequent floods during the short rains (September-November) caused so much damage that losses due to disease tended to be overlooked. As a consequence, the number of specimens sent into the Advisory Laboratory was unusually small and totalled 306, compared with 350 in 1960 and 638 in 1959.

Cereal Diseases.—The report of the Cereals Pathologist is included with that of the Senior Research Officer (Plant Breeding).

Coffee Diseases.—The report of the Coffee Pathologist is included with that of the Senior Research Officer (Coffee).

Bacterial Wilt of Potatoes

A detailed survey of bacterial wilt of potatoes was carried out in Central Province and a total of 678 crops were examined. This is approximately 2 per cent of all holdings in Central Province in which potatoes are grown in the long rains (April-June). The amount of bacterial wilt on the potato crop at each site was recorded as follows:—

(1) No disease.

(2) Light infection (less than 1 per cent of the plants diseased).

(3) Moderate infection (1 per cent to 5 per cent of plants affected).

(4) Heavy infection (more than 5 per cent of the plants affected).

After presence or absence of the disease had been determined by a general inspection of the whole field, the disease ratings were estimated by sample counts of 100 plants within each field. The survey showed that rather more than half of the potato fields in Central Province were free from bacterial wilt, and that in diseased fields the density of infection varied from light to moderate. These figures were obtained during the long rains season which was abnormally dry; it is

thought that the intensity of the disease in affected fields might be higher during a wetter season. Surveys during the abnormally wet short rains season could not be made as Potato blight (*Phytophthora infestans*) was so serious that bacterial wilt symptoms were masked. Full details of the survey will be published separately.

Dr. Hayward of the Commonwealth Mycological Institute has identified *Pseudomonas solanacearum var asiaticum* on eggplant; this is the first record of this strain in Africa and the first Kenya record of a strain other than the common "non-browning" potato and tomato strain. The disease was found near Nairobi

Potato Blight

The variety Rosslyn Eburru, which contains four major genes for resistance to blight, was released in Kenya in July, 1961. Blight was found on this variety near Nakuru in November and the race attacking it was subsequently identified as Race 1234, which has not previously been recorded in Kenya.

Sugar-cane Smut

Field studies on varietal susceptibility to Sugar-cane Smut (*Ustilago scitaminea*) were continued during the year. The disease is now common throughout the cane-growing areas of Central Nyanza and Coast Provinces. In a trial carried out in Central Nyanza, 25 varieties were tested for their field susceptibility to smut. From the results of this trial and from general field observations, it has been shown that the varieties Co.270, Co.290, Co.301, Co.312, Co.396, Co.419 are all susceptible to smut. It is fortunate that the two varieties which show most promise in Central Nyanza, Co. 331 and Co.421, possess a moderate degree of resistance and these varieties should serve to tide the industry over the dangerous period during the search for new, smut-resistant varieties. Variety B.41227 grown under irrigation is also resistant to smut in Kenya.

Commercial stocks of Co.421 in Kenya are badly contaminated with Co.270 which is highly susceptible to smut. While Co.421 shows a good degree of resistance to smut, commercial crops which are contaminated with Co.270 have the appearance of being susceptible. It is most important, therefore, that care is taken to ensure purity of variety when propagating Co.421 commercially.

Certain cane varieties appear to have different smut susceptibilities in different parts of the world and some of the susceptibilities in Kenya differ from those recorded elsewhere. For example, Co.421 is resistant in Kenya and Natal, but susceptible in India, Co.290 which is reported to be resistant in world literature is highly susceptible in Kenya; Co.331 which is reported as being susceptible in India is resistant in Kenya; and Co.270 which is reported as fairly resistant elsewhere is susceptible in Kenya. Other varieties, however, conform to published susceptibility ratings. Thus, Co.312, Co.453 and Co.301 are very susceptible in Kenya, Co.417 is fairly susceptible, Co.419 is susceptible and Co.408 is fairly resistant to smut.

Passion Fruit

Work on the selection of Australian varieties of passion fruit resistant to Woodiness Disease (described in the Annual Report for 1959) continued throughout the year.

Pyrethrum

During the abnormally wet short rains (September-November) there was some increase in the incidence of Bud Disease (*Ramularia bellunensis*) and "False Bud

Disease" which is attributed to a physiological disorder. Although this increase caused concern among growers, it was not considered important owing to the close correlation of disease incidence with weather conditions.

Onions

The disease known as "Blast" and caused by *Botrytis allii* was recorded at Perkerra in July. This is the first time it has been seen in Kenya and it caused considerable damage to the onion crop. The characteristic early symptom of the disease is the numerous white spots which occur on the leaves. This symptom is followed by a dieback of the foliage. Symptoms resulting from blast may be confused with those caused by thrips, drought or excessive soil moisture; with blast, however, the dieback is invariably preceded by the characteristic leaf spotting.

Fungicide Investigations

Studies on fungicides during 1961 were confined to seed dressing treatments of beans and maize, these two crops having given inconclusive responses to seed treatments during the 1960 series of trials. Various rates of Captan, Thiram, Spergon and organo-mercurial fungicides were used on beans in trials at Embu, Kitale, Sotik, Njoro, Kakamega, Katumani and Scott Laboratories. Captan, Thiram and organo-mercurial fungicides were used in trials on maize at Kitale and Katumani. The results of all these trials were again inconclusive and the value of fungicidal seed dressings on these crops in Kenya has still to be demonstrated.

Mycological Herbarium.—The following determinations were received from the Commonwealth Mycological Institute during 1961. Those marked with an asterisk are new records for Kenya.

Host	Fungus	C.M.I. Accession Number
Agave sisalana	*Leptostroma vestitae**	87301
Alloteropsis cimicina	*Cercospora* sp.*	88929
Arundinaria alpina	*Lapularia sphaerospernia*	84403
Bauhinia brizantha	*Cercospora fusimaculans**	85667
Brassica oleracea	*Cercosporella brassicae**	87171
Cucumis sativus	*Cercospora citrullina**	86656
	Leveillula jamica	85356
Cynodon dactylon	*Ustilago hitchcockiana*	84404
Digitaria scalarum	*Phyllachora digitariae*	84405
Glycine max	*Ascochyta sojaecola**	89409
Lactuca capensis	*Septoria lactucae*	84599
Musa sapientum	*Nectric inverta**	84402
	*Verticillium cinnebarinum**	84402
Ocimum guave	*Perenospora* sp.*	87170
Pelargonium sp.	*Thyronectria pseudotrichia**	86657
Persea gratissima	*Dothiorella aromatica**	89929
	Thyronectria sp.*	89203
Phormium tenax	*Glomerella phasidiomorpha*	89205
Thunbergia alata	*Oidium* sp.	84408

In addition to the determinations given above, the C.M.I. identified many specimens which were collected over a period of a decade or more and sent to Kew during 1961. These have not been listed as they are all included in *Host Lists of Kenya Fungi and Bacteria*, C.M.I. Mycological Paper No. 81, by R. M. Nattrass.

Nematode Investigations

In September, Dr. John P. Hollis, Fulbright Scholar, arrived at the Scott Laboratories and initiated investigations on problems associated with nematodes. Soil fumigation trials were conducted using EDB, DD and Nemagon to investigate the nematode problems on pineapples, sisal, tea, coffee, beans and pyrethrum. Dr. Hollis also initiated nematode surveys.

The Potato Development Programme

In October, the inaugural meeting of the Potato Research Advisory Committee was held and this was followed by a second meeting in November. This Committee, on which farmers are strongly represented, is to advise Government on the course which potato development should follow in the future. During the year, final releases of promising varieties of previously imported potato material were made to growers. A temporary ban has been imposed on further importations pending assessment of the dangers of inadvertently importing the new Virus "Y", and the second compatibility group of blight (*Phytophthora infestans*).

Variety testing was carried out during both rainy seasons. During the long rains there was a total of only 14.6 in. of rain during the growing season and blight was not serious. Thirty-one varieties were tested during the short rains crop when there was a total of 43.6 in. The rainfall during this period was too high for good yields to be recorded, but it did provide useful variety susceptibility data to blight under severe conditions. Five variety trials were laid down in various parts of Kenya. The results of these showed that Mexican polygenic blight-resistant varieties gave the best yields but produced tubers with poor market acceptability; the variety Rosslyn Sasamua yielded well and it is of a fairly high market quality. Rosslyn Sasamua is a major gene-resistant variety and was attacked by blight during the short rains at Scott Laboratories.

During the year cooking tests were made on 23 of the more promising varieties. Apart from their own intrinsic value, these tests were useful in enabling several varieties to be discarded before further unnecessary work was done on their blight susceptibilities and field performance.

As noted elsewhere in this report, the variety Rosslyn Eburru, which has four major genes to blight resistance, was released during 1961 and the new race 1234 appeared on it within four months of release. It has now been decided to abandon major gene-resistant selections as a means of controlling blight and to concentrate on polygenic resistance.

Legume Bacteriology

Rhizobium Extended Evaluation Trials

Eighty-eight of these trials, which were described in the Annual Report of 1960, were conducted during 1961, 70 of which gave useful results. Following experience gained during 1960, fewer trials of a more complex design were conducted. Each trials contained four plots, and the treatments consisted of (1) Scott Laboratories inoculant, (2) imported inoculant, (3) uninoculated control with no nitrogen fertilizer and (4) uninoculated control with nitrogen fertilizer. The following legume species were used in the trials:—

Glycine max.,
Dolichos lablab,
Crotalaria juncea,
Pisum sativum,
Medicago sativa,
Lupinus sp.,
Lotononis bainesii,
Trifolium repens,
T. subterraneum,
T. semipilosum.

The object of these trials is to determine the extent of natural nodulation and the effect of inoculants on various legumes species in various localities in Kenya. Results obtained so far show that natural nodulation in Kenya does not take place with *T. repens, T. subterraneum, Medicago sativa, Lotononis bainesii, Pisum sativum* and *Lupinus angustofolius*. However, *Dolichos lablab, Crotolaria juncea, Trifolium semipilosum* and *Glycine max.* do form natural nodules in certain areas. The results concerning the effect of the inoculants should be related to the presence or absence of natural nodules in the control plots; these results are complex and cannot be summarized easily in this report. Full details will be published when the series of extended evaluation trials is completed.

Nitrogen Fixation Measurement Trials

Trials were conducted in an attempt to assess the amount of nitrogen being fixed by various legume species in various localities. The trials were laid down as randomized blocks with four replications and are designed to express the amount of nitrogen fixed by inoculated legumes in terms of equivalent response by comparison with a series of uninoculated controls with different levels of nitrogenous fertilizer. Five of these trials were laid down at Njoro but all were lost due to drought. Four were laid down at Molo but drought again interfered and only one produced worthwhile results. Present indications are that legumes in Kenya can fix amounts of nitrogen comparable to figures obtained in temperate countries, at least when the nutrient status of the soil is high.

Manufacture of Inoculants

Fifty-seven orders for inoculant, involving 314 units, sufficient to inoculate approximately 9,000 lb. of seed, were received during 1961.

Seed Testing

General

During the year a record number of 3,086 samples of seed were tested for purity and germination. The analysis of these tests is as follows:—

(*a*) Government and experimental tests	635
(*b*) Cereals and other food crops	615
(*c*) Grasses	690
(*d*) Vegetables and flowers	1,146
Total ..	3,086

The germination and purity testing for the Seed Wheat Certification Scheme has continued. During 1961, 24 certificates were issued. Eleven certificates for germination and purity of Government-tested seeds were issued for seed for export. Ninety entries were tested for the Farm and Dairy Produce Section of the R.A.S.K. Show in Mitchell Park. The experiment to test the effect of fungicidal seed dressings on the longevity of coffee seed, which was described in the 1960 report, was continued. It was not completed by the end of the year. An experiment was also conducted to test the longevity of seed stored both in Mombasa and Nairobi in (*a*) airtight jars, after having been sealed in vacuum-packed tins, (*b*) paper packets sealed in polythene and (*c*) the usual paper seed packets. Experiments on the longevity and dormancy of six grasses and *Trifolium subterraneum*

are continuing on behalf of the Senior Pasture Research Officer ; this seed is tested at monthly intervals. A longevity trial on molasses grass which is being stored at Scott Laboratories since 1953 has continued ; this seed is tested every six months.

Regional Referee Seed Testing

Scott Laboratories joined Region 5 of the Regional Referees' Testing Scheme sponsored by the International Seed Testing Association. Region 5 includes Australia, New Zealand, Japan, New Delhi, Salisbury and Pretoria.

R. A. ROBINSON,
Senior Plant Pathologist.

ANNUAL REPORT OF THE SENIOR SOIL CHEMIST

Soil Surveys

F. W. Collier

Field work on Survey of Kenya series GSGS 4786, sheet No. 119/1 which covers the Solai area reached an advanced stage though some 37,000 acres, mainly in heavy forest, remain to be covered. The account of the soils here is being written up as the field and laboratory work progresses.

A report on the soils of the Upper Ewaso N'giro catchment area in relation to potential irrigation development was prepared and submitted for incorporation as an appendix to the Hydrologist's report being published on the hydrology and water development of the catchment. An irrigation suitability map of the soils of the Upper Catchment was also prepared and has already been printed for incorporation with the report. The Ewaso N'giro survey is being rounded off by extending its coverage to soils which on account of their inaccessibility to water are unsuited to irrigation and by classifying the soils which have been observed and demarcated under the survey on a pedogenetic basis. The preliminary draft of this survey report is now compiled.

The report of the East Konyango soil survey and the maps to accompany it were printed and are now on sale. The Enlow reports on agriculture and on the grassland situation in Kenya were seen through the Press.

In the Solai survey, the pliocene and more recent lavas were found not to have weathered deeply and to underlie shallow stony soils of low agricultural potential except in situations where local relief had led to the accumulation of soil. The older lavas had given rise to deep friable red soil. Pumice and ash from Mount Menengai, East Rift wall fissures and possibly from outside the survey area, were found to have made major contributions to the soil over wide areas. The main pumice beds lie to the west of Mount Menengai and smaller beds lie banked up against the footslopes of the East Rift escarpment on the far side of the Bahati plain. They extend very little to the north. The soils to which these pumice showers have given rise typically are made up of series of layered beds of raw pumice and very dark brown to black fine humose material. Tuffaceous soil parent material derived from the ash showers is very much more widespread than pumice and may be found wherever there is flat land on the shelves along the eastern wall of the Rift Valley. It is to the high sodium felspar content of this ash that the development of sodium dominated soils in areas of impeded drainage on the shelves is now attributed.

Climate contributes to soil formation in the Solai area mainly through rainfall, cloud incidence, humidity and temperature. On the Rift Valley floor, the annual rainfall averages about 35 inches and comes predominantly in showers and storms separated by periods of bright sunlight and in well defined seasons separated by long intervals of warm or hot dry weather. With increasing altitude comes an increase in rainfall, a decrease in the intensity of precipitation and in the length and intensity of the periods of bright sunlight between showers and storms and of the dry seasons, and a fall in temperature to the point that above 7,500 feet or so, the country is buried in cloud for long periods each day for much of the year. With the warmth and dryness of the low country goes a

seasonal fire hazard leading to the dominance of bush or savannah vegetation. At the higher altitudes, this gives way to cedar and ultimately to highland forest with grassy glades confined to areas where drainage is impeded or the soil is shallow. Normal soil development under free draining conditions in the high country is to a considerable depth and the soils have a deep highly humic top soil and are strongly acid. At lower elevations with the increasing dryness, goes less top soil development, less organic matter accumulation in the top soil, less intense acidity and the tendency for sodium dominated soils rather than swamps to develop in low lying land.

The Ewaso N'giro environment generally is dryer and more exposed to dessicating wind but cooler than the Solai environment. Furthermore the soils of the plains here have been derived from rocks which have been much more influenced by comparatively recent lava flows and ash showers than the Solai rocks. Soil development on the plains of the Upper Ewaso N'giro catchment started under restricted drainage conditions with the result that even though there have been tectonic earth movements which have now tilted the land surface into free draining conditions the soils retained profile characteristics going with poor drainage. The comparative dryness under which these soils have developed has led to the considerable accumulation of calcium carbonate in the subsoil. The relative coolness and humidity and freedom of drainage which is characteristic of the sites of the soils of the lower mountain slopes of Mount Kenya has resulted in the upland soils there being markedly acid. The highest areas surveyed on the mountain slopes are so wind swept that forest has survived only in sheltered locations and more forest is to be found in the comparative shelter of the lower elevations. Between the plains and the mountain slopes, a transition zone is now recognized in which small scattered areas of medium textured red soils typical of the mountain slopes and probably relics of past forestation are surrounded by heavier textured dark brown degraded soils akin to the soils of the plains. Where many of the permanent rivers of the Upper Eawso N'giro catchment flow out on to the plains, the gradient of their beds flatten so much that they support long ribbons of seasonal or permanent swamp. Here the soils are deep sticky and plastic, extremely acid clays coloured blueish-grey to grey-brown with many rust mottlings along old root channels near the surface and on the face of the structural elements of the deeper soil. These soils characteristically have toxically high contents of available aluminium and maintain peat surface layers where the swamp is permanent.

Soil Chemistry

A. Mehlich and R. J. Kempton

In February, 1961, Dr. A. Mehlich returned for a further two-year period in Kenya under A.I.D. He concerned himself particularly with the chemical characterization of clay minerals and with the mechanisms of retention and release of the major plant nutrients in soil in areas of adequate rainfall for successful crop growth.

The main lines of investigation he followed concerned the exchange characteristics of laboratory precipitated alumino-silicates of claylike composition, the reaction of water soluble phosphates and sulphates with these preparations and the effect of heat on the acid extractability of phosphate from various soils. The alumino-silicate preparations were formed by reacting solutions of aluminium

chloride and sodium silicate together in varying proportions to one another at controlled acid levels. The proportions of aluminum to silicon used well covered the range found in natural clays. Except where the ratio of silicon to aluminum was narrow, the presence of magnesium or calcium chloride was found necessary for the coagulation and precipitation of the alumino-silicate and as this ratio widened so the necessary amount of added salt increased. Even at the highest levels of concentration of the added salt, however, the magnesium or calcium needed entered little, if at all, into the composition of the alumino-silicate precipitate. In all instances, the proportion of aluminum to silicon in the alumino-silicate approximated closely to the proportion in the reacting solutions.

The alumino-silicates so formed were found to have base exchange capacities associated with permanent and pH dependant charges in just the same way as natural clays. At the narrowest ratio of silicon to aluminum used (0.44 : 1) as much as 95 per cent of the base exchange capacity of the precipilate was associated with pH dependant charge: this was found for each of the acidity levels at which alumino-silicate was precipitated. As the ratio of silicon to aluminum widened so the proportion of base exchange capacity associated with permanent charge increased: at a silicon/aluminum ratio of 0.88 : 1 this was much more apparent when the medium in which the alumino-silicate was precipitated was alkaline than when it was neutral or acid. When the silicon to aluminum ratio was 1.75 or higher, there was considerable development of basic exchange capacity due to permanent charge, even when the reaction medium in which the alumino-silicate was precipitated was neutral, and when the silicon to aluminum ratio was as wide as 5.25 : 1, over 95 per cent of the base exchange capacity of the alumino-silicate was associated with permanent charge whether the medium in which the alumino-silicate precipitated was prepared was acidic, neutral or basic.

Ageing of acidified sodium silicate-aluminium chloride sol at pH 2 very substantially reduced the total negative charge as measured by titration with sodium hydroxide.

Synthetic alumino-sulphate gels failed to produce negative charge exchange capacity. Synthetic alumino or ferri-phosphate gels produced principally variable negative charge exchange capacity. Under these conditions the metal cations associated with the sorbed dihydrogen phosphates were found in solution as hydrolysis products. These phosphates included the calcium, potassium and ammonium mono basic phosphates.

Reaction of dihydrogen phosphates with soils having high anion exchange capacities also showed the metal cations associated with the added phosphate not to enter the exchange complex to any extent. In contrast, metal cations associated with mono hydrogen phosphate were strongly adsorbed by the soil. Thus ammonium from mono ammonium phosphate was more readily leached than that from diammonium phosphate. The calcium from superphosphate was also subject to considerable leaching loss. The movement of these important nutrients away from the root zone particularly when the root systems are still small greatly reduces their effectiveness in areas of high rainfall. Hence better results with seed bed applications of phosphate and nitrogen are expected when the fertilizer application is based on mixtures of water soluble monohydrogen and dihydrogen phosphates, suitable forms of which for use are on the one hand, diammonium phosphate, and on the other hand, double superphosphate. An initial small trial which was

laid down during the short rains at Scott Laboratory in connexion with the testing of this view, promised to support it strongly, for here, the crop receiving a seed bed application of nitrogen and phosphate as a mixture of double superphosphate and diammonium phosphate has made much better growth than the crop receiving the same dressing of nitrogen and phosphate as seed bed dressings of sulphate of ammonia and double superphosphate. An extensive more critical appraisal of the validity and agricultural application of this concept is planned for 1962.

In the heat studies, a number of samples of soil which had been heated in an electric furnace to 150 or 250° C. for two hours or to 350, 550 or 750° C. for one hour, together with samples of the same soils unheated were extracted with normal sulphuric acid by shaking one part of soil with 50 parts of the dilute acid for one hour, standing overnight and then shaking for another hour: parallel samples were digested by shaking the soil and extractant for one hour followed by digestion on a boiling water bath for 40 minutes. The extract was decolourized with charcoal and filtered and the phosphate contents of the filtrates were estimated.

Temperature was found to have little effect on acid extractable phosphate in bentonite or dominantly montmorillonite soil. By heating to 250 and 350° C. 90 to 100 per cent of the total extractable phosphate from alophane and halloysite dominated soils and from limonite was made extractable.

While soils containing a good proportion of kaolinite might release phosphate in the 250 to 350° C. range, they also showed a progressive phosphate release up to the 750° C. maximum to which the heating was carried. With goethite and with soils containing principally mixtures of kaolinite and montmorillonite, or kaolinite and halloysite, there was a gradual release of phosphate over the entire heat range.

The patterns of release of phosphate from these materials accord well with the known or expected changes which these materials undergo on heating and which find expression in the inflections of their Differential Thermal Analysis curves. The 250 to 350° C. range over which a marked release of phosphate was recorded with many of the materials examined, is the range over which these materials undergo structural changes with the loss of combined water, while the tendency towards the release of phosphate above 550° C. where kaolinite is an important soil constituent takes place in a temperature range over which kaolinite undergoes major changes in its structure with the release of considerable amounts of energy.

Some of the phosphate even in a peat and a muck was similarly associated with the minerals which the evidence available indicated as likely to be present in these materials.

This revelation, that most of the soil phosphorus that we had come to regard as held in an organic form could well be present as phosphate in association with mineral clays, must lead to much new thinking regarding the retention of phosphate in soil and its relation to soil fertility.

Meanwhile soil data following the Mehlich procedures continued to be collected on samples from soil surveys, from soil fertility trials and in connexion with general farming advice. There was a heartening increase in the number

of samples sent in by District Agricultural Officers undertaking systematic sampling surveys in connexion with their compilation of background information to crop production and crop production potential in their districts.

The nutrient availability data of 15 contrasting East African soils were obtained at Scott Laboratory along with other important East African routine soil analysis laboratories and the relationship of the data has been examined statistically. Remarkably close correlation between indications of the different laboratories has been revealed for most factors determined. Nevertheless a number of less satisfactory measurements were brought to light among which was the Scott Laboratory method for potash determination in very highly saline soils. The limitations of our potash determination method are receiving further investigation.

Biological Investigations

A. Pinkerton

Staff changes during the year necessitated the incorporation of our activities in connexion with field fertilizer trials with the bioassay work, while the demands of the Research Committees for sisal and pyrethrum have resulted in redirection of part of the pot investigation work into basic nutritional studies of these crops.

Further improvements in growing conditions in the greenhouse. and in economy in water consumption of the crops growing in it was achieved by providing for the spraying of the floor of the greenhouse with cold water in hot weather.

A further nine soils from the Solai survey area were examined, partly for the Soil Surveyor and partly to fill in the pattern of copper deficient soils in the Nakuru district. They all came from sites between Menegai Crater and the Bahati Forest and none proved to be deficient in copper, though the range of available copper as given by the *Aspergillus niger* assay was on the low side (1.4 to 3.6 p.p.m.). Five were low in nitrogen and all were very deficient in phosphorus, while all but one responded to additions of sulphur. There were no other important responses. One soil which had been investigated in 1960 and which then showed indications of trace element deficiency was examined further and copper deficiency was confirmed. It came from the west side of the Menegai Cauldron and had estimated available copper of 1.2 p.p.m.

Seven soils representative of type profiles in the Nanyuki survey area were tested. All but one were severely deficient in phosphorus and five in nitrogen. Five responded to sulphur though only two of these responses were of any magnitude. There were no indications of any other deficiencies of either major or minor elements.

The nutritional studies started with the search for sand suitable for culture work involving the major elements at least. The Geological Department suggested the Arabuko-Sokoke deposit used by the Mombasa Glass Works as the most likely suitable source, the sand there being derived from Karoo sediments washed down by the Sabaki River and deposited in a lagoon of Pleistocene or Pliocene age. Owing to the calm nature of the lagoon there was little or no wash back of coral detritus from the enclosing reef, and the sand is much whiter than the

normal surrounding lagoonal material. Eleven sites in the deposit were sampled and examined chemically and biologically. The most promising sample was that from the site at present being worked and is low by chemical analysis in all the elements except phosphorus (8 p.p.m.). The "−P" figure for Cunninghamella was 40 per cent "+all". Severe phosphate deficiency symptoms quickly developed in tomato plants with phosphate grown in the sand. Similarly the "−N" and "−S" figures were 16 per cent and 80 per cent respectively and deficiency symptoms appeared rapidly. The one element of which deficiency symptoms did not appear quickly was calcium, this in spite of low content of 0.02 m.e. per cent. Acid extraction and acid washing of the sand will be necessary before it is satisfactory for experiments involving deficiency levels of this element.

Meanwhile the view was reached that water culture is a more satisfactory medium for trace element work, so a suitable assembly for the purpose was elaborated using covered polythene pots and providing for aeration of the nutrient solution by intermittent streams of air being bubbled through the solution in each pot.

A set of sand pots was prepared for gaining local experience of the deficiency conditions associated with major nutrient deficiencies in sisal which have been described by the Tanganyika Sisal Station at Mlingano. Having these at hand will enable trace element nutrient deficiency symptoms to be differentiated from the major element symptoms. For the investigation of trace element nutrition a set of water cultures was similarly set up, the bulbils used for it being stripped down to the youngest leaves and then rooted in sand before being suspended in the culture solutions: the aim of so doing was to reduce to a minimum the risks of trace elements which the young plants would contain.

The plants deprived of nitrogen, sulphur and iron quickly became pale green in colour but otherwise early growth has been healthy and vigorous.

Pyrethrum investigations so far have been concerned mainly with testing the practicability of undertaking pyrethrum nutrition studies in local conditions, this being necessary because the Scott Laboratories are situated well outside the areas normally recognized as good pyrethrum country in Kenya and have a much warmer climate and a much more intense dry season. The initial run has been in sand and the opportunity of making it was taken to try the effect of withholding each of the major nutrients. The splits used were obtained from a clone from 100 A seed which flowers well at the Scott Laboratories. These were established satisfactorily and the young plants have grown away well.

A subsidiary investigation concerned the mottling and check in growth occuring with the use of a commercial hydroponics fertilizer. The investigations indicated the trouble to be due to an initial ill-balance of the proportions of nutrients in the fertilizer which would best be overcome by splitting the application.

The fertilizer trials in African areas continued and the available 1961 results have been accumulated for statistical analysis on the Rothamsted computor. The available results of the 1960 trials are summarized overleaf, the overall means for the most frequently tested crops in the successful trials being shown and the number of trials contributing to each mean being quoted in brackets immediately below that mean:—

Crop Particulars	Double Superphosphate			Sulphate of Ammonia			Manure				Muriate of Potash		Lime			
	0	¾–1½ cwt.	2–3 cwt.	0	1–1½ cwt.	2–3 cwt.	0	4–7½ tons	10–12 tons	15–22 tons	0	½–2 cwt.	0	5,000 lb. per acre	11,000 lb. per acre	16,500 lb. per acre
English *potatoes*, bags per acre	35 (9)	47 (6)	48 (9)	40 (9)	41 (4)	42 (9)	42 (6)		47 (3)	49 (6)	31 (3)	21 (3)				
Maize, 1 and 2 season residuals on red soils from volcanic rocks, lb. per acre (i.e. N and K reapplied, P.M. applied either L.R. or S.R. 59).	1,885 (15)	2,189 (13)	2,228 (11)	2,014 (15)	2,135 (14)	2,506 (8)	1,696 (15)	2,527 (9)	2,142 (2)	2,511 (11)	2,158 (4)	2,168 (4)				
Maize, red soils from volcanic rocks lb. per acre (*all* ferts reapplied).	1,962 (3)	2,418 (3)	2,553 (3)	2,269 (3)	2,286 (3)		1,884 (3)	2,562 (3)								
Maize, 2 and 4 season residuals on reddish soil from siliceous rocks, lb. per acre (i.e. P and M applied in L.R. 58 or 59 and only N in L.R. 60).	2,318 (8)	2,800 (8)	3,110 (2)	2,495 (8)	2,790 (8)	2,941 (2)	2,453 (8)	2,648 (8)		3,174 (2)						
Maize, 2 and 4 season residuals on pallid soils from siliceous rocks, lb. per acre (i.e. P and M applied in L.R. 58 or 59 and N only in L.R. 60).	2,445 (9)	2,513 (9)		2,110 (9)	2,551 (5)	3,392 (5)	2,252 (9)	2,681 (9)								
Maize, pallid soils from siliceous rocks lb. per acre (all ferts reapplied).				1,178 (2)	1,813 (2)	2,445 (1)	1,258 (2)	1,790 (2)	2,340 1()							
Maize, 2 and 4 season residuals on coastal soils, lb. per acre (i.e. P and M applied in L.R. 58 or L.R. 59, N and K re-applied).	878 (13)	928 (13)		855 (13)	954 (13)	1,391 (2)	841 (13)	990 (13)			825 (11)	842 (11)				
Beans, 1–5 season residuals on red soils from volcanic rocks lb. per acre (i.e. M.P.K. applied L.R. 58, S.R. 58, L.R. 59, S.R. 59, or L.R. 60; N and K re-applied; Lime applied L.R. 57).	215 (21)	304 (15)	255 (19)	242 (21)	276 (15)	251 (13)	230 (18)	314 (8)	364 (5)	258 (12)	171 (5)	172 (5)	139 (3)	149 (3)	169 (3)	153 (3)

The benefits of double superphosphate application for English potatoes and for maize on reddish soils and the persistence of its residuals wherever phosphate responses are observed were again apparent; also the general benefit of manure, particularly for maize, and of sulphate of ammonia for maize on pallid soils from silaceous rocks and on coastal soils. Beans showed very little response to the residuals from lime on soils of extreme acidity though here the level of yield was so low with all treatments that the observation has little practical significance.

Lime Trials

L. A. Whelan

This report provides a summary to date of the investigation begun in 1953 into the effects of liming on some important soil types in the Kenya Highlands and on the crops grown on them. Experiments were laid down at four sites; Kaptagat, Eldoret, Molo and South Kinangop. The first three are reddish brown loams and the last a grey kaolinitic loam. The pH of the soils was approximately 5.0 and the Cation Exchange Capacity as m.e. per cent in order of naming 26.2, 21.7, 30.1 and 12.8. Local limestone was used in both coral and dolomitic forms and at Kaptagat a third form was included, the hydroxide prepared from the dolomitic material. The coral was fairly constant in composition, 38.0 per cent Ca and 0.5 per cent Mg but the dolomitic material varied considerably with a mean of 29.3 per cent Ca and 3.9 per cent Mg.

Limestone was reapplied at Kinangop in 1959 to half the number of plots that had initially been limed. Calmag was applied to half the number of plots in each of the lime treatments at Molo in 1960 and at Kinangop in 1961 in order to provide a wider spread of soil Ca:Mg ratios.

The amounts of material applied and the year of application are tabulated below. In this and later tables L_0 refers to unlimed plots, L_1, L_2 and L_3 to those given dolomitic limestone, H the hydroxide and M coral limestone. R refers to plots relimed and/or given Calmag.

Pounds per Acre Limestone or Calmag

	L_0	L_1	L_2	L_3	H	M	
Kaptagat, 1953	—	4,400	8,150	17,740	6,420	13,000	Limestone
Eldoret, 1953 ..	—	6,860	11,000	—	—	6,150	,,
Kinangop, 1954	—	3,400	6,000	—	—	3,000	,,
Kinangop, 1959	—	2,690	5,280	—	—	2,400	,,
Molo, 1954 ..	—	8,300	15,000	—	—	7,400	,,
Molo, 1960 ..	700	1,200	3,120	—	—		Calmag
Kinangop, 1961	340	1,130	1,300	—	—		,,

Fertilizers were applied each year of the wheat cycle. Double superphosphate at nil (P_0), 100 (P_1), 200 (P_2) and 400 lb. (P_3) per acre was applied at planting. At Eldoret the 400 lb. dressing was omitted. Differential sulphate of ammonia (N) and muriate of potash (K) applications each at 200 lb. per acre were made when the plants were about knee high. At Molo and Kinangop the N and K were combined. At Eldoret only the K and N+K treatments were given, the N alone being omitted. Wheat was grown on three of the sites and barley on Kinangop except for the last year of the cereal cycle when wheat was planted.

Grain Yields

The yields of cereal for each site are given below as mean annual yields in lb. per acre. The figures in brackets give the number of seasons over which the means were obtained.

Response to Lime

	L_0	L_1	L_2	L_3	H	M	L.S.D.
							5% 1%
Kaptagat (4) ..	1,084	1,353	1,220	1,094	1,366	1,173	not significant
Kinangop (4) ..	965	1,023	1,080	—	—	1,060	„ „
Molo (2) ..	1,011	1,247	1,280	—	—	1,288	134 182
Eldoret (5) ..	471	511	510	—	—	534	not significant

The mean annual responses to lime were small at all sites and statistically significant only at Molo. In 1955 at Kaptagat the stiff strawed variety 341 was planted and on the unlimed plots the mean yield was only 208 lb. per acre whilst the limed treatments which showed little variation among themselves gave a mean yield of 1,057 lb. In the following year the Sabanero variety gave 1,055 lb. on the unlimed plots, the lightly limed plots had little effect on yield, the moderate application L_2 caused a significant decrease ($P<.05$) of 506 lb. and the heavy application L_3 a further drop of 417 (almost significant $P<.05$). The differences between calcitic and dolomitic forms were significant in only one year at one site, Kinangop 1954, when the coral form gave 736 lb. and the dolomitic 674 lb.

Responses to Superphosphate

	P_0	P_1	P_2	P_3	L.S.D.	
					5%	1%
Kaptagat (4) ..	890	1,327	1,316	1,327	70	93
Kinangop (4) ..	672	1,099	1,186	1,173	73	106
Molo (2)	607	1,169	1,571	1,487	289	421
Eldoret (5) ..	308	569	642	—	62	83

The responses to phosphate were highly significant at all sites but varied in magnitude from year to year. At Kaptagat the maximum response was obtained with the small application, indeed in 1954 the higher applications caused a significant ($P<.01$) progressive decrease in yield, P_0 1,863, P_1 2,479, P_2 2,154 and P_3 1,929, probably due to the severe lodging on the P_2 and P_3 plots making harvesting difficult. At Kinangop and Eldoret the maximum responses were obtained at the P_2 level but in 1955 the heaviest application P_3 decreased the yield significantly ($P<.05$) P_2 1,326 lb., P_3 1,055 lb.

Responses to K or NK mixture

	K_0	K+	NK+	L.S.D.	
				5%	1%
Kaptagat (4)	1,148	1,277	—	40	54
Eldoret (5)	438	530	550	62	83

The responses to potash at Kaptagat and Eldoret were highly significant. The interaction between response and years was also highly significant there being no significant response at either centre during the last two years of the cycle. In 1953 at Kaptagat the incidence of stem and leaf rust was much less where potash had been applied.

There was no indication of a response to N from the mean annual yields at any site. The straw from the 1954 seasons at Kaptagat and Eldoret was ploughed back on a plot basis and the straw from half of each plot of the Kinangop 1955 season was also ploughed back. The following crop at Kaptagat gave an indication of a response to N, an increase from 686 to 1,144 lb. At Eldoret the mean yields for the following crop were:—

O	K	NK	L.S.D.	
			5%	1%
408	485	561 *lb.*	95	128

There was a highly significant response to the NK mixture.

At the Kinangop there was no response in any season to the NK mixture. At Molo the mixture increased the yield in 1954 from 1,422 to 1,533 lb. ($P<.05$).

At the end of the cereal cycle, grass clover mixtures were planted at Eldoret and Molo primarily to rest the soil from wheat. At Kinangop a crop of kale was grown before seeding to grass. At Kaptagat the experiment was discontinued.

KINANGOP KALE

Fertilizers as for the cereal cycle. The mean yields as tons per acre green material were:—

L_0	L_1	L_2	M	L.S.D. 5%	L.S.D. 1%
9·08	10·80	12·96	10·29	1·94	2·63

	P_0	P_1	P_2	P_3	Mean
−NK ..	4·15	9·05	9·81	10·33	8·34
+NK ..	4·23	16·42	15·75	16·41	13·20 L.S.D. 1% 1·86
Mean ..	4·19	12·74	12·78	13·37	

L.S.D. 5% 2·33 1% 3·45

The smaller applications of limestone did not produce significant responses but the heavy application gave a highly significant increase of nearly four tons. The small superphosphate dressing gave a highly significant response with no further increases from the higher rates. The NK mixture gave a highly significant response and the interaction between P and NK was significant, the response to P being much greater in the presence of NK.

GRASS YIELDS AS TONS PER ACRE

Several cuts for yield have been made to date and mean treatment yields are given below as tons per acre either as green material (G.M.) or dry material (D.M.).

A grass clover mixture was planted at each site. The clover germinated well but quickly died out except at Eldoret. In 1960 the superphosphate was found to be exerting a strong influence on the clover grass balance in favour of the clover but this had largely died out in 1961.

The first column gives the date of harvesting. The letters in column two indicate that the relevant fertilizer was applied in that year prior to harvesting (N ammonium sulphate, K muriate of potash, C Calmag, D differential application, O overall application, RL relimed).

EFFECTS OF LIME

(1) *Kinangop. Planted June,* 1959

	L_0	L_0R	L_1	L_1R	L_2	L_2R	M	MR	L.S.D. 5%	L.S.D. 1%
Dec. RL. 1959	4·13	—	4·29	5·59	4·96	8·25	4·46	5·45 G.M.	2·75	3·75
Aug. 1960	0·31	—	0·49	0·44	0·30	0·33	0·34	0·33 G.M.	not significant	
Dec. C. 1961	3·78	4·49	3·48	5·03	4·76	4·09	4·53	3·71 G.M.	1·36	—

(2) *Molo. Planted perennial ryegrass and Louisiana white clover July,* 1957. *Replanted Westerwolths ryegrass July,* 1961

	L_0	L_1	L_2	M	L.S.D. 5%	L.S.D. 1%
March 1958 ..	1·07	2·35	3·04	2·57 G.M.	0·47	0·64
Nov. 1958 ..	4·09	6·17	7·34	6·08 G.M.	1·27	1·74
Aug. 1959 ..	0·94	0·82	0·79	0·86 G.M.	not significant	
Nov. 1961 C.	1·17	1·17	1·11	1·13 D.M.	„	„

(3) *Eldoret. Planted Rhodes grass and Kenya wild white clover May,* 1958

	L_0	L_1	L_2	M	L.S.D. 5%	L.S.D. 1%
Nov. 1959..	3·8	4·7	5·2	4·3 Scored	0·8	1·1
July 1960 ..	0·33	0·44	0·53	0·45 D.M.	0·07	0·09
Oct. 1961 ..	0·98	1·27	1·24	1·13 D.M.	not significant	

In the early years of the ley lime has produced significant responses at all sites. Heavy reliming at Kinangop has significantly increased the yield by 3.3 tons. No marked yield response has yet resulted from Calmag applications but the small dressing at Kinangop significantly increased yield by 1.5 tons (L_1 R versus L_1).

Effect of Phosphorus

There has been no significant effect of P at Kinangop or Molo. At Eldoret the scoring in 1959 showed a highly significant decrease from 4.83 tons at P_0 to 3.77 tons at P_2. In 1961 the check weights showed the opposite effect, a highly significant increase from 0.99 tons D.M. at P_0 to 1.31 tons at P_3.

Effect of Nitrogen

Kinangop

Differential ammonium sulphate applications were given in 1959 and the following cut showed a significant increase ($P<.05$) from 4.34 to 6.0 tons G.M. In 1960 nitrogen was not applied and the mean yield was only 0.36 tons. In 1961 overall N was applied and the mean yield was 4.23 tons.

Molo

	−NK	+NK	L.S.D. 1%
March 1958	2·23	2·29 G.M.	—
October 1958 D.N. ..	4·67	7·17 G.M.	1·23
August 1959 D.N. ..	0·67	1·03 G.M.	0·22
Replanted July 1961 ..			
November 1961 D.N. ..	1·14	1·15 D.M.	—

Eldoret

	O	K	NK	L.S.D. 1%
November 1959 D.N.	3·7	4·0	5·8 Scored	0·97
July 1960 D.N.	0·38	0·36	0·58 D.M.	0·06
October 1961 D.N.	0·94	0·96	1·56 D.M.	0·28

The grass has consistently shown a significant response to N except the replanted ryegrass at Molo.

Lime Phosphorus Interaction

It has been indicated earlier that response to phosphate decreases with liming. Birch found that in a wide selection of East African soils P response was inversely related to pH and to citric and soluble silica.

The results below are taken from the mean annual yields of the three crops grown on the Kinangop and give the percentage responses to the heavy phosphate application at all lime levels. The mean pH and citric soluble silica figures are also given for the cereal cycle.

Lime Treatment	L_0	L_1	M	L_2
% response to P_3 Barley	110	70	63	63
% response to P_3 Kale	473	276	153	155
% response to P_3 Grass	20	2	−15	−23
pH (1 : 1 aqueous)	5·1	5·6	5·8	6·0
S_1O_2 ppm	51	60	62	69

Similar results were obtained at the other sites and support the conclusions arrived at by Birch.

EFFECT OF LIME ON THE SOIL

Soil samples were taken annually from all plots to a depth of approximately seven inches. Sampling was usually done in December-January and always when the soil was dry or slightly moist.

pH 1 : 1 Soil water suspensions

	Initial pH	Maximum pH	Months	Final pH	Months
Kaptagat	5·0	6·3	25–37	6·2	68
Eldoret	4·9	6·3	19–32	6·1	92
Molo	5·0	6·5	12–24	5·9	85
Kinangop	5·0	6·1	12–20	5·9	83

At all sites the figures refer to pHs obtained on the most heavily limed plots. The second and third columns show the maximum pH obtained and the time taken to reach it in so far as the infrequency of sampling permits. The figures for the relimed and calmag treatments are not included in the above means. The maximum effect was reached between one and three years and at Kaptagat and Eldoret was approximately maintained for at least seven years. At Molo there was a considerable drop in pH. At Kinangop the final difference between limed and unlimed plots was less than that shown above because of the increase in pH of unlimed plots from 5.0 to 5.4 due to the high pH in the sub soil—6.8 at approximately 18 inches depth.

The liming factor for the dolomitic material was 1.6 at Molo but somewhat higher (a mean of 2.3) at the other three sites. The factor for the calcitic material was also low at Molo 1.3 but rose to approximately 2 for Kinangop and Eldoret. The materials used for the foregoing results were all finely ground. At Kaptagat where the calcitic material used was much coarser the factor was 2.8.

EXCHANGEABLE BASES

Exchangeable base determination was made on soil samples taken in 1957 by Mehlich's triethanolamine-barium chloride method (T.E.A.) and on samples taken in all years by his rapid acid extraction method (S.A.L.) as used for routine testing in these laboratories. To estimate the efficiency of the S.A.L. technique the results obtained on the 1957 samples were expressed as percentages of the amounts of exchangeable bases found in the same samples by the T.E.A. method. The mean percentage values for Ca on all sites rose with increasing rates of liming, L_0 58 per cent, L_1 73 per cent, L_2 78 per cent. The mean value for Molo at all application levels was 90 per cent but for the other three sites was approximately 65 per cent. The percentage value for Mg 110 per cent shows a much closer relationship between the two methods, whilst for potash the value is nearly 80 per cent.

The percentage base saturation figures obtained by the two methods (for both the C.E.C. was taken as the sum of the cations found by the T.E.A. technique) were also compared by expressing the S.A.L. figures as percentages of the T.E.A. Again the values rose with rate of liming, the means for all sites being L_0 72 per cent, L_1 85 per cent, L_2 88 per cent and again Molo gave the closest relationship, 107 per cent for all levels. The per cent B.S. values obtained by the S.A.L. method give a useful indication of the base status if it is kept in mind that the results generally tend to be somewhat low. The per cent B.S. (S.A.L.) figures corresponding to the final pH figures given earlier are set out overleaf.

	Kaptagat	Eldoret	Molo	Kinangop
Unlimed	13	22	16	33
Heavy liming ..	37	36	35	46

The results indicate the presence of considerable amounts of the added bases still in the soil several years after application.

Percentage Base Saturation and Response to Lime

It has been suggested (1959 Annual Report Government Chemist, Tanganyika) that irrespective of C.E.C. levels, Ca, Mg and K saturations of 20 per cent, 5 per cent and 2 per cent respectively should be adequate for red earths.

The unlimed soils described have the following percentage saturations:—

	Ca	Mg	K
Kaptagat	11	6	4
Eldoret	19	11	4
Molo	8	5	5
Kinangop	30	6	2

The soils substantially below the 20 per cent level for Ca are Molo and Kaptagat and these give approximately 25 per cent response whilst Eldoret and Kinangop with a much higher Ca saturation give only 10 per cent increase in yield on liming. Increasing the Mg content of the soil by adding dolomite in place of coral limestone has had no effect on yield. Application of potash has given significant yield responses at Kaptagat and Eldoret but these show highly significant interactions with seasons and may be climatic effects. The results generally support the Tanganyika findings.

Soil and Plant Phosphorus and Yield Response

With the large amount of double superphosphate applied—four annual applications each of 400 lb. per acre are equivalent to an addition of approximately 150 p.p.m. P to the soil to plough depth—it was considered worthwhile to determine what percentage of this could be extracted by the S.A.L. routine method. The initial values for these P responsive soils were Kinangop 17 p.p.m. and Molo 11 p.p.m. P. At Kinangop after one application the extractable P had risen by 6 p.p.m. or 16 per cent of that added and after four applications by 63 p.p.m. or 42 per cent of that added. At Molo, however, the corresponding increases were only 3 p.p.m. or 8 per cent and 4 p.p.m. or 3 per cent. This locking up of the applied P is common to all the red soils. The Cunninghamella technique for P availability was also tried on a number of samples. The results were somewhat eratic but the difference between the grey and the red soils was less marked than with acid extraction.

In view of the importance placed by some workers on the organic P of the soil as a source of available P, determination of this fraction was made by a modification of Mehta's method.

	Kaptagat	Eldoret	Kinangop	Molo
Organic P as ppm	90	88	50	167
Organic P as % of total P	10	11	19	26
Ratio Wackley Black C: organic P	240	180	430	210

The amounts of organic P estimated by this method are small, especially in the Kinangop soil. The C:P ratio indicates that the mineralization of organic P is much greater on the grey than on the red soils. There was an indication that liming had slightly decreased the amount of organic P at all four centres.

Chemical analysis of plant material indicated that as a result of superphosphate application there was a small increase in wheat leaf P about the time of flowering accompanied by a large increase in grain yield whilst with grass a big increase in P content was accompanied by no change in yield.

Soil Nitrogen Status by Cunninghamella Method

Under wheat the soil N status as indicated by this method was considered satisfactory. Application of ammonium sulphate resulted in no increase in leaf N and no increase in yield when the straw from the previous crop was not ploughed back.

Under wheat the Cunninghamella values were Kinangop 50, Eldoret 40 and Molo 30 but after two or three years under grass the respective values were 5, 9 and 16. Application of ammonium sulphate increased the yield and also increased leaf N content.

Calcium and Magnesium in Soil and Plant

Wheat

The exceptionally good yield of 1,960 lb. grain per acre from the no lime Kaptagat plots in 1954 was followed by a reduction in percentage Ca saturation of the soil from 7 per cent to the very low value of 4 per cent. If the 341 variety sown the following year has a high Ca requirement (leaf Ca increased from 0.27 per cent on L_0 plots to 0.36 on L_3) this may explain the extremely poor yield of 200 lb. on the no lime plots rising to 1,000 lb. on the limed plots.

The small limestone applications reduced the Mg content of the leaf whilst the heavier applications of dolomitic limestone increased it slightly. Thus in the 1955 Kaptagat season the Mg contents as per cent of dry matter were L_0 0.14, L_1 0.14, H 0.11, M 0.12, L_2 0.16 and L_3 0.17. The application of KCl at Kaptagat reduced the leaf Mg (mean of 1955 and 1956) from 0.16 per cent to 0.13 per cent but had no detrimental effect on yield.

Grass

Analyses were made of grass samples from the Molo 1958 and Eldoret 1960 cuts. Results are given below together with soil Ca and Mg percentage saturation figures and yields as tons of dry matter per acre. As the trends were similar, only mean values of the two sites are given.

	L_0	L_1	M	L_2
Soil Ca % saturation ..	10	20	23	28
Leaf Ca %	0·31	0·37	0·39	0·40
Soil Mg % saturation ..	7	9	7	10
Leaf Mg %	0·18	0·20	0·19	0·20
Yield tons per acre ..	0·58	0·84	0·83	1·00

Liming has in both instances had a marked effect on soil and leaf calcium but a much smaller effect on magnesium content. The yield has also been increased considerably.

Potash

The potash content of both wheat leaf and grass was high except for Rhodes Grass at Eldoret (1.22 per cent K). Generally the application of KCl resulted in an increase of leaf K of approximately 15 per cent.

Manganese

Soil Mn in the three red soils had a mean value of about 1.0 m.e. per cent reduced by liming to approximately 0.8 m.e. per cent. There was a corresponding drop in plant Mn from about 220 p.p.m. to 100 p.p.m.

Aluminium

Aluminium was reduced in Kaptagat wheat leaf by lime and superphosphate applications from approximately 120 p.p.m. to 80 p.p.m. by liming and to 60 p.p.m by heavy phosphate dressings

Soil Physics

D. D. Evans

With the new Soil Physics Laboratory fully equipped a comprehensive investigation programme was started. This involved crop sequence studies under conditions of unreliable rainfall at Katumani; the determination of the irrigation requirements of sugar cane and cotton and the investigation of the drainage needs of some of the soil of the Kano Plains; the physical characterization of potential irrigable soils in the Upper Ewaso N'giro catchment; the investigation of methods of improving the irrigation characteristics of certain difficult soils at Mwea and at Perkerra and participation in the investigation of the irrigation of pineapples on the Horticultural Research Station near Thika.

The Katumani studies were continued with repetition of the cycle started in the 1960 L.R. A new cycle was started in the 1960 S.R., a second in the 1961 L.R. and another in the 1961 S.R. The report of the Agricultural Officer (Research), Southern Province, should be consulted for further information on these cycles.

The soil moisture contents before the start of the test crop season in the trials started both in 1960 L.R. and 1960 S.R., even under the fallow, were much below the levels corresponding with the 0.3 atmosphere percentages which are widely taken as the field capacity of soil, and were in fact close to the 1 atmosphere percentages. To gain information on what might have been the fate of the water represented by this difference in the percentages, a simple field investigation was undertaken. Two adjacent plots each 20 feet square were levelled in quarters. Six inches of water were applied to each quarter and allowed to enter the soil, the water being taken up in one or two hours. As soon as the water had disappeared from the surface, one of the plots was covered with plastic sheeting and the plastic was covered with about one inch of dry soil. The other plot was left bare. The soil moisture content at different depths was determined on both plots over a 68-day period following the flooding and during which there was no rain. The moisture distribution pattern was related to the moisture/tension characteristics of the soils concerned, determined on the basis of disturbed and undisturbed soil samples taken following the last moisture sampling.

The surface soil dried out in under three weeks to near wilting point (10-12 per cent moisture) on the bare plot, while the moisture content of the surface soil of the covered plot fell only to about 1 atmosphere percentage (16-18 per cent) and stayed around that level throughout the rest of the 68-day period covered by the observations. However, the depth of drying of the bare plot was limited to the top two feet. On the covered plot the moisture content remained around the one-third atmosphere percentage level for the first 11 days after flooding and then dropped over the next 7 days to around the 1 atmosphere level, at which it remained thereafter and which was the level typical of the fallow plots in the crop sequence trial.

That this fall in moisture content to a level considerably below what is normally regarded as field moisture capacity cannot have been due to lateral movement was determined in the last sampling of this trial. This sampling showed that throughout the four feet of profile on which measurements were made, lateral movement, even in this permeable dry soil, was confined to a region of five feet on either side of the plot boundary. This distance is now taken as the minimum discard which must be allowed to the plots to get away from edge effects in soil moisture experiments.

The Kano Plains irrigation experiments got away well. A cotton trial was concerned with the possibility of using irrigation with a view to gaining advantages which were believed to come with January or February planting as well as collecting information on the irrigation requirements of the crop. The dry land variety S.47 was used in the trial. For irrigation control two soil samples were taken twice weekly from each plot for moisture content determination and plots were watered individually as soon as the mean moisture content of the two samples fell to prescribed levels of 75, 50 and 25 per cent of the total available water content. A high standard of pest control was maintained.

Though faulty initial irrigation led to a poor stand in the January planting, at the end of August the mean yield from this treatment exceeded the mean yield from the February planting (1,226 lb. and 1,116 lb. seed cotton respectively) and both yielded two, to two and a half times as much as the March planting (510 lb. per acre). Heavy rain from September onwards put paid to further picking. Irrigation treatments were generally more than adequate; the yield from

a total application of 14.0 inches to the January planted crop was slightly better than that either from an application of 18.9 inches or one of 26.3 inches (1,296 lb., 1,272 lb. and 1,104 lb. respectively).

The most economic use of irrigation was the 7.8-inch application to the February planting which was necessary to sustain the lowest moisture level for that time of planting: this gave rise to a yield of 970 lb. per acre which was not significantly different from the highest yielding treatment. In future trials it is planned to use an irrigated cotton for the irrigation treatments in the hope that this will respond even better to the best of the combinations of planting and irrigation.

Irrigation trials on sugar cane were started at Miwani and Ahero. The early stages of the Miwani trial suffered from theft of much of the field recording equipment and in effect water applications at first were much the same at all the three levels of irrigation (75, 50 and 25 per cent of available water) adopted. There were real differences in the irrigation treatments applied in the second half of the year and even though the short rains set in early and were heavy and persistent, considerable growth differences between the irrigation treatments and between irrigated and non-irrigated cane have developed. The Ahero trial got away to a late start and finished the year under four feet or so of water as the result of flooding of the nearby Nyando River.

A consideration of the data on stream flows and water storage potential of the rivers traversing the Kanyo Plain accumulated by Sir Alexander Gibb and Partners (Extension of Kenya Nile Basin Water Resources Survey 1960/61) showed it imperative to determine the effect on production of severely limiting water application to permanent crops such as sugar cane during the low flow season which occurs between December and March each year. Accordingly, further irrigation trials on sugar cane on the Kano Plain are being instituted with this in view: full irrigations will be given for eight months of the year and differential irrigations will be given only in the four months of low flow: these dfferentials will be applied to cane of different ages at the low flow season.

The Meteorological Station at Ahero was strengthened by the provision of a wind recorded and the installation of a Gunn-Bellani radiation integrator. This equipment is installed with a view to calculating potential evapotranspiration following the Penman formula and to relating it to the actual measured consumptive requirements of the crops.

The drainage investigations concerned the growing of sugar cane on Kibigori clay, a black cotton soil of low permeability on which a great deal of the potential expansion of sugar cane production in Nyanza must take place. A trial was successfully laid down in which 12 feet and 24 feet cambered beds were compared, some with the rows running along the beds, some with the rows running across the beds and with gypsum applied at the two tons per acre rate which had been found highly beneficial locally compared with a no gypsum control. The treatment combinations all provided sufficient drainage for good cane growth. Associated soil moisture measurements have traced a pattern of water movement in the profile in harmony with the wetness and dryness of the seasons. In spite of the low permeability of this soil these seasonal changes were discernable throughout the depth of profile sampled. The trial site was made completely inaccessible by flooding in the short rains.

The Ewaso N'giro studies involved profile sampling of five typical potential irrigable soils to depths of up to five feet and the determination of the hydraulic conductivity, and the moisture percentages of these samples at 0.1, 0.3, 1, 5, 10 and 15 atmosphere combinations and bulk densities. The moisture percentage and bulk density data were used to estimate the available water holding capacity of the soil. The values obtained ranged from 0.9 to 2.4 inches of potential stored water per foot, the highest values being for the surface soils and for the heavy black clays and swamps of the plains and the lowest values for the sub-soils and for the red soils of the lower mountain slopes. Hydraulic conductivity was critically low only in the sub-soil and the swam soil though pan development in the sub-soil of one of the mountain red soils showed itself in the low hydraulic conductivity of one of the layers in that soil. The sample of heavy black clay of the plains was adequately permeable.

The irrigation problem of the Mwea was the excessive permeability of the red soil there. Laboratory compaction and infiltration studies showed that this could be reduced adequately for the purpose of surface irrigation by lightly loading the soil when it was wet. A field trial on similar red soil at the Scott Laboratories showed that this reduction in infiltration could be achieved satisfactorily in the field by dragging a small "V" shaped drag along the furrow behind the advancing water front. This demonstration of the feasibility of reducing water infiltration in the field led to a new intensification of investigation into red soil utilization on the Mwea/Tebere scheme to the point that five pilot holdings each of three acres were opened on this soil. On these the possibilities of peasant settlers making a livelihood growing different crops under various irrigation systems were examined. The crops comprised maize, beans, onions, tomatoes, cabbage, cauliflower, sugar cane, banana and asparagus. Irrigation was by basin, inclined plane or sprinklers. The crops just got away before the short rains set in but were under water for prolonged periods the rest of the year. A good deal of this flooding has now been traced to seepage from nearby irrigation and from canals which border and traverse the site of this excessively permeable soil, leading to the building up of a water table on the underlying less permeable rock. This water table could quickly build up to the surface whenever it had the opportunity.

The Perkerra problem concerned the very high frequency of irrigation which had been found necessary for keeping onions growing on much of the developed land of this scheme. The soil concerned was found to have a low laboratory water infiltration rate though this was easily doubled by a variety of gypsum treatments. However, when measures to improve water infiltration were tested in the field it was found that the intake rate of the untreated soil was quite adequate—about one inch per hour—while the applied treatments did not improve it. Subsequent field studies and laboratory determinations of particle size distribution have shown that the trouble is due to an excessively high content of silt accentuating the droughting effects of the heat and dryness of the local climate. The water relations of such a soil can best be improved by building up its humus level rather than by seeking mechanically and chemically to improve its infiltration characteristics. The testing of possibilities in this direction was held up by a general attack of onion "blast" which played havoc with the commercial onions on the scheme as well as the onions on the trial.

The contribution of the Soil Physicists to the pineapple experiment is the characterization of the soil on which a nitrogen fertilizing and spacing trial has been laid out. As part of this, the uniformity of water application by the part-circle sprinklers used to irrigate the plots was determined.

Crop Product Investigation

H. C. Hodgson

In the laboratory, the reproducibility of the electrophoretic separation of protein of wheat gluten on starch gel which had shown promise of success in 1960 was found to be extremely poor. The trouble was attributed to irregularities in the adsorbtion and colour development characteristics of the nigrocene indicator strain which needed to be used to detect the zones of concentration of the fractions. This was so great as to preclude any possibility of comparative determinations.

The apparatus for the chromatographic separation of sulpho-cystenyl glutens on an anion exchange column and the subsequent recovery of the components was completed. Separation of the gluten derivatives started with pre-treatment of the column with TRIS buffer at pH 8. The sulpho-cystenyl gluten sample was then applied and the column eluted stepwise with increasing concentrations of buffer at constant pH. The eluent was collected in 5 ml. portions, a total of 140 fractions covering a fivefold increase in buffer concentration being taken. These yielded one major and three minor components, the last of which was obtained by incorporating urea in the buffer solution. The major component represented just over one-third of the applied protein and since it appeared soon after elutiation commenced, it probably contains some components which had not been adsorbed and separated on the column. Most of the added protein was held by the column and not recovered.

The 1960 sowings of the wheat maturation trial were of early and late planted Regent and African Mayo at Ol Joro Orok and Njoro. Weekly harvests were taken from each planting, starting three or four weeks before full ripeness and continuing through to over ripeness. The late sowing of African Mayo at both centres and of Regent at Njoro produced a stronger dough than the early sowing but the late sowing of Regent at Ol Joro Orok produced a slightly weaker dough than the early. The dough strength benefits to be gained from the late sowings are insufficient to justify the greater risk of loss of crop from rust which goes with them.

In connexion with a proposal that Kenya should be more nearly self-sufficient in malt, the possibility of improving the malting characteristics of steely barley by wetting came under investigation. Following an observation in 1960 that successive wettings and dryings can lead to an increase in mealiness a 200 lb. bag of three steely commercial maltig barleys were maintained at a moisture content of 22 per cent for 96 hours and were then dried to 10 per cent moisture. Mealiness determinations were made before and after treatment with the following result:—

Sample No.	1	3	2
N%	1·6	1·7	2·6
Before Treatment—			
% mealy	2	2	0·5
% semi-mealy	34	14·5	36·5
% steely	64	83·5	63

After Treatment—			
% mealy	5·5	3·5	1·5
% semi-mealy	38	29	45
% steely	56·5	67·5	53·5

The treatment even of samples one and three which have acceptable or nearly acceptable nitrogen values brought about insufficient improvement in mealiness for a single moistening to be worthwhile. Repeated moistening was considered to be impracticably complicated for commercial production of mealy barley even if this leads to an adequate improvement in mealiness.

The possibilities of essential oil geranium as an alternative crop in many of the better watered parts of Kenya attracted so much interest that over 50 new growers have applied for and received authentic Reunion cuttings on which to start bulking up their own plantings. The demand for cuttings continues. A few specimens of Reunion geranium cuttings which the importer claimed to produce a superior oil to the official importation were received from the East African Quarantine Station and were planted with a view to doing a test distillation. Trial distillation of the geraniums grown on the pilot scheme under peasant conditions in Embu are reported to have produced an oil of such excellence as to need toning down to make it acceptable to the perfumery trade.

A small plot of ninde (*Aeolanthus gamwellii*) was successfully established with seed from Northern Rhodesia but though the plants have grown and flowered well and are highly aromatic they have set no seed as yet. The planting of Rosatta (*Rosa damascena*) which was rescued from oblivion a few years ago, has produced a few flowers at Scott Laboratory and is reported to be flowering well at Molo. Samples of French and Italian sweet basil oil (*Ocimum basilicum*) distilled from plants grown on the shores of Lake Naivasha received high commendation from the Tropical Products Institute. The yields from the initial distillations were rather low however, and it seems that thorough wilting is necessary for full release of the oil. As the Naivasha plantings were in danger of being lost, seed was obtained from them and plots of the two strains have been successfully established and are seeding at the Scott Laboratories in preparation for further bulking and further distillations.

Lime oil samples from a distillation of Coast fruit on the other hand drew critical comments on its physical and chemical properties and odour. The trouble in part was the inadequacy of the press used to squeeze the fruit and the number of days taken for a consignment of juice to be collected, despatched and distilled. These shortcomings will be avoided in the next distillation.

A comparative method has been developed for the assessment of the colour of pineapple pulp. This involves the preparation of a series of colour standards by precipitating aluminium hydroxide in the presence of varying amounts of potassium dichromate. This gives a series of gelatinous precipitates with a range of intensities of yellow with which the colour of macerated pineapple pulp can be matched. The colour determinations are part of a survey of pineapple production being undertaken by the Horticultural Section.

The method of diosgenin analysis recommended by Boots Ltd., for the evaluation of Dioscorea yam tubers has been brought under examination.

Analytical Data

R. J. Kempton

The following analytical data obtained during 1961 is of general interest:—

Foodstuffs and Plant Tissues

Commodity	Moisture %	Oil %	Crude Protein %	Fibre %	Ash %	
Bamboo—						
Leaves	3·3	2·0	18·6	30·5	20·9	
Small leaves and twigs	3·8	1·6	14·4	32·4	22·0	
Stems	1·9	0·6	3·5	60·1	8·9	
Twigs	3·4	1·0	6·7	38·5	19·3	
Barley	11·2	—	12·6	—	—	
Black feed beans, crushed	11·8	11·7	23·6	7·1	4·0	P 0·26% Ca 0·25%
Brewers Grains	10·2	4·3	13·5	5·9	1·9	
Castor seed	5·2– 5·9	42·0– 51·0				
Chick feed	10·1– 10·6	4·3– 4·5	23·3	7·1 8·1	17·3– 18·6	
Cotton seed	6·9	5·9	25·6	30·8	4·5	
Cotton seed cake	4·7– 8·1	7·2 —	25·2– 41·4	—	—	
Doum Palm Nut Meal—						
Dried skin and pulp of nuts (33% of nut)	11·6	1·0	5·0	20·7	7·8	
Fibrous cover of kernel (39% of nut)	7·2 9·9	0·7 7·7	1·3 5·3	53·0 32·6	2·7 1·6	
Fodder Grass samples ex Mtwapa	4·0– 15·6	0·9– 2·4	6·6– 17·4	28·9– 45·1	6·6– 15·5	
Grass, Ol Joro Orok	10·0	—	6·9– 9·9	—	—	
Grass from sheep grazing trial Ol Joro Orok	— —	2·6– 4·4	12·1– 21·1	22·6– 31·4	10·3– 17·6	
Grass, Rhodes ley 15 days after topping	16·9	1·9	14·1	27·6	8·8	Ca 0·35% P 0·16%
Grass, Rhodes ley 29 days after topping	26·1	1·8	12·3	25·2	7·2	Ca 0·38% P 0·18%
Jute Seed	8·5	13·2	21·0	18·4	19·4	
Leleshua leaves	8·3	8·0	10·6	20·4	9·9	
Lucerne	10·4	2·8	21·5	23·2	9·4	
Lucerne, Eldoret	8·6– 10·1	—	19·8– 23·2			
Lucerne, Naivasha	5·9– 7·6	—	20·5 25·2	—	—	
Lucerne meal	10·4	—	18·4	—	—	
Lupins	—	—	—	—	—	Alkaloid 0·01– 0·12%
Maize cobs crushed whole	11·8	3·3	7·9	11·1	1·4	Ca 0·02% P 0·2%
Rice bran	10·5	7·1 13·1	7·7– 10·6	7·7– 15·2	8·9– 13·9	
Rice dust	10·7	14·2	9·5	3·5	6·9	
Safflower seed	7·6	8·3	—	—	—	
Silage	82·1– 84·7	0·5	1·5– 2·6	5·6– 6·0	2·2– 2·6	
Silage, Oat/pea/vetch	73·5	0·8	2·5	8·7	3·5	pH 4·1%
Sisal waste	72·3– 79·2	—	1·04– 1·58	—	—	
Sunflower husk	11·2	6·7	12·9	17·6	7·4	
Stalk	9·0	27·5	10·3	6·2	5·0	

FERTILIZERS

COMMODITY	Moisture %	Total N %	P_2O_5 %	K_2O %	Ash %	
Deep litter poultry manure	10·9	2·0	5·8	1·4	49·2	Na_2O 0·8% acid insoluble 10·1%
Mushroom bed compost ..	11·6	1·32	0·53	1·15	—	Ammonium N 1·10%
Superphosphate	7·9	Total	37·5	—	—	
		Citric Soluble	36·7			

Publications

A Guide to Fertilizer Use in Kenya: E. Bellis, published in the *Kenya Farmer* and subsequently as a booklet.

Charge Characterization of Soils: A. Mehlich, published in the *Proceedings of the 7th International Congress of Soil Science,* Vol. II, pp. 293-302.

Charge Characterization as a Criterion for Classification of some Equatorial Soils: A. Mehlich and P. T. Miller, published in the *Proceedings of the 7th International Congress of Soil Science,* Vol. IV, pp. 432-442.

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Some Relationships between Isotopically Exchangeable Phosphate, Soil Analysis and Crop Growth in the Greenhouse: G. E. C. Mattingly and A. Pinkerton, *Journal of the Science of Food and Agriculture,* Vol. 12, No. 11, pp. 772-777.

Acknowledgements

Mention has been made of the arrival of Dr. Mehlich and an account has been given of the activities of the Soil Physics Section. The work involved is the direct result of the support which continues to be given generously to land use investigations in Kenya by the United States Government through its Agency for International Development. This Agency also continues to contribute generously to the purchase of equipment needed for the section to operate as a modern and efficient unit.

Finally, we must express our gratitude for the continued co-operation and forbearance of the farming and commercial public in the contacts we have with them.

E. BELLIS,
Senior Soil Chemist.

ANNUAL REPORT OF THE SENIOR PLANT BREEDER

The report this year is presented in a revised form so that the work in the separate programmes may be seen more clearly. Thus, section A is a report of the work based on the Plant Breeding Station, Njoro, and mainly concerns wheat; sections B and C are contributions from the plant breeders at Kitale and Machakos, covering their maize programmes for Western Kenya and Southern Province respectively. It is now six to seven years since these latter were first launched and the progress being achieved is very satisfactory.

A.—Report from Njoro

1. Review of the Year

The weather in 1961 ranged from very severe drought to prolonged excessive rain; it produced a season of unusual difficulty for plant breeding and of disaster amongst farmers. The drought conditions in the early part of the year were followed by outbreaks of "army worm". Wheat had a dry start but by September looked better than ever. Exceptional and continuous rain from October through to December damaged the grain of the crops nearing harvest, and later crops in the higher areas became so affected by disease that little grain was developed. Harvesting and grain-drying under such conditions proved very difficult. Due to the earlier drought, rust was exceptionally low in incidence, but nevertheless the other diseases brought on by the rain did tremendous damage and what should have been a record year for Kenya's wheat yields was reduced to one of disaster for most farmers.

Maize crops differed greatly according to area. The poor rainfall in the 1960/61 short rains and the long rains brought famine to Southern Province in particular. In Nyanza the exceptional late rain led to poor cropping, but in the main Highlands maize areas the yield will probably have come close to the average level. These comments are expanded in sections B and C of this report, from Kitale and Katumani respectively.

Table 1—Rainfall, 1961

Month	Njoro		Kitale		Katumani	
January	0·05	(1·02)	0·12	(0·99)	0·04	(1·31)
February	0·22	(1·35)	1·24	(1·45)	0·49	(1·55)
March	0·77	(2·80)	0·71	(2·42)	1·72	(3·42)
April	3·45	(5·25)	4·49	(5·88)	2·71	(6·36)
May	3·00	(4·62)	3·74	(6·65)	1·55	(2·01)
June	1·93	(3·21)	5·33	(5·01)	0·18	(0·33)
July	2·08	(4·33)	8·70	(6·29)	Nil	(0·08)
August	6·35	(5·02)	7·73	(6·68)	0·20	(0·09)
September	1·49	(2·78)	5·68	(4·18)	0·77	(0·37)
October	7·24	(1·99)	9·44	(2·65)	7·21	(1·35)
November	16·29	(2·57)	14·27	(1·83)	20·25	(4·39)
December	5·83	(1·79)	5·27	(1·54)	6·26	(3·10)
Totals	48·70	(36·73)	66·72	(45·57)	41·38	(24·36)

Notes

(1) Rainfall is expressed in inches.

(2) Figures in brackets are the averages over the last 31 years for Njoro, 25 for Kitale and 36 for Katumani.

Within the Plant Breeding Section, 1961 was a year of general consolidation and in spite of the crop difficulties considerable progress was achieved. One important new development forecast last year can now be recorded: the Rockefeller Foundation has awarded a substantial grant to the Plant Breeding Station for an expansion of testing international collections of wheat for rust resistance. The grant is to run for three years and covers both special staff for the project and an extension of laboratory and housing facilities. A plant breeder to take charge of this work has not been recruited so far, but good response is being shown to the inquiry addressed to wheat breeders throughout the world for material for screening. The project has aroused considerable interest and can be of considerable benefit both to Kenya itself and to breeding wheats for rust resistance on a world-wide basis.

2. Survey of Field Crops

The wheat acreage altered little in 1961, as shown in Table 2, but total production was expected to run at a record figure due to the very good prospects before harvest. The early estimates of yield for 1961 were in the region of seven bags per acre, an increase of two bags over the figure for 1960; but in the event the average yield fell to only some 4 bags and much of that is of low grade, sprouted or otherwise damaged.

The maize acreage in the Scheduled Areas revived considerably in 1961, as also did those for barley and oats. For maize and oats the acreage returned approximated to that of 1957/1958; barley was still low following the severe slump in 1959.

Table 2—Cereal Acreages and Yields, 1955-1961
(Scheduled Areas Only)

Year	Wheat		Maize		Barley		Oats	
	Acres 1,000	Bags/ acre	Acres 1,000	Bags/ acre	Acres 1,000	Bags/ acre	Acres 1,000	Bags/ acre
1955	345	3·93	158	7·89	24	6·62	19	6·72
1956	316	4·43	166	7·67	42	7·29	25	7·85
1957	239	4·78	167	8·04	52	6·67	26	6·88
1958	235	4·58	124	9·37	56	6·70	21	6·86
1959	256	5·54	115	9·28	39	7·69	19	7·70
1960	220	5·06	118	8·55	21	7·72	11	6·61
1961	227	4·09	147	8·46	31	3·90	—	—

(Figures are taken from the Board of Agriculture statistics for cereal production in the Scheduled Areas. Bags refer to 200 lb. net for wheat and maize, 180 lb. for barley and 150 lb. for oats.)

Varieties.—The continuing change in the pattern of wheat varieties is shown in Table 3, and there has been a marked increase in the popularity of recent releases. Some 80 per cent of the acreage was sown with varieties released in the last five years. The change to these follows the increased incidence of rust on most of the varieties previously grown; it has also been stimulated by the higher yield levels that the newer wheats have been attaining. Advice to farmers on the choice of varieties and the new releases is published in the local Press each year. (*Vide* "Releases and Choices of Cereals for 1961", by G. E. Dixon, published in the *Kenya Weekly News* of 17th February, 1961.)

The table clearly shows the very marked reduction in the popularity of the wheats Sabanero, 1066 and Baby Equator, and the big increase in the acreages of Africa Mayo, Wisconsin Supremo, Mida-McMurachy-Exchange and Kentana Yaqui. These four wheats came to Kenya in the International Spring Wheat Nurseries of 1954 and 1955 and after selection from single nursery rows were multiplied for direct issue. They demonstrate the great value of such sources of new varieties, and have been very successful in providing interim issues at a time when there was a marked shortage of Kenya-bred varieties.

TABLE 3—WHEAT VARIETY ACREAGES, 1958-1961

Varieties and Years of Release (In order of acreage in 1961)	Annual Percentage of Total Wheat Acreage			
	1958	1959	1960	1961
Africa Mayo .. .. .. (1959)	—	1·1	5·5	12·3
Wisconsin Supermo .. .. (1960)	—	—	1·9	10·3
Sabanero/1066/Baby Equator .. —	47·7	25·3	27·6	9·7
Mida–McMurachy–Exchange .. (1960)	—	—	1·4	8·8
Kentana Yaqui/Yaktana .. (1960)	—	—	3·8	8·7
Kenya 358 .. .. .. (1957)	6·2	10·8	13·7	7·8
Kenya 363 .. .. .. (1957)	4·3	9·0	11·1	6·4
Frontana–Kenya–Newthatch 25 (1959)	—	—	—	5·1
Kenya "Bird" varieties .. .. (1959)	—	4·8	20·8	4·7
S.A. No. 43 .. .. .. (1961)	—	—	—	2·6
Veranopolis .. .. .. (1961)	—	—	—	1·6
Kenya 374 .. .. .. (1961)	—	—	—	1·4
Gala .. .. (1961)	—	—	—	0·7
A.K.M.S. x Yaqui[2] .. .. (1961)	—	—	—	0·6
Other Varieties	41·8	49·0	14·2	19·3

The acreage devoted to "Bird" varieties fell back markedly as was to be expected after their severe damage by stem rust in 1960. A special point that may be added here is that over 80 varieties were being grown in 1961, many of them surviving almost as personal varieties when they have long been outdated for general use. Following a review of this and the difficulties caused, as many as possible have now been declared redundant and efforts are being made to eliminate them. There is likely, therefore, to be a decline in the figure for "other varieties"; in 1961, though they were mostly present in only fractional amounts, they still covered 19 per cent of the wheat acreage, and exceeded any one individual variety.

A welcome effect of the change of pattern of wheat varieties in 1961 is that almost 50 per cent of the acreage was planted to varieties of good baking quality. This is a considerable step forward from the very difficult position that came to a head in 1957.

Barley and oats had a poor season, but occasion no special comment here.

Disease.—As usual this report is accompanied by a separate contribution from the Plant Pathologist on the rust and disease position; however, certain general points must be mentioned.

The incidence of wheat stem rust was very low compared to recent seasons, a fact that is attributed to the severity of the dry season. Conditions were not unsuitable for rust but the initial inoculum for the start of the usual epidemic seemed lacking. On the other hand a new form made its appearance in several places, including Njoro, attacking the variety Wisconsin Supremo and various new wheats based on *Triticum timopheevi*.

The main losses of wheat from disease this year were due to Glume Blotch (*Septoria nodorum*), Leaf Blotch (*Septoria tritici*) and Leaf Blight (*Helminthosporium tritici-repentis*). Singly or in combination these diseases became very active in all the later wheat areas and were very largely responsible for the disastrously low yields. Varietal differences in susceptibility were generally of a low order, though Kentana Yaqui and Yaktana were particularly badly damaged by Glume Blotch to which they were already known to be prone. No. 43 was also affected rather badly; such points have been noted in relation to advice for 1962, but in general the choices for next planting must still be made in relation to rust rather than these usually minor diseases.

Whilst stem rust was abnormally quiet in 1961, the range of races in Kenya has now been extended by the new form already mentioned that is attacking *T. timopheevi* derivatives. It is impossible to predict which races may re-establish themselves in epidemic form in 1962, but taken together they still represent a very considerable threat to the wheat industry of Kenya, and the light attacks in 1961 must not lead to any complacency.

3. Breeding—Wheat, Barley and Oats

A decrease in the number of plots at Njoro reflected the very severe screening of the extensive South American collections of 1960. This, however, was offset by a marked increase in the number of Kenya-bred crosses in early breeding generations.

Some 11,950 plots were grown at Njoro, together with a further 2,168 at Molo and Ol Joro Orok; to these figures can be added the general trial and observation programme. Again the receipt of further collections from various sources, and especially from Colombia and Beltsville, U.S.A., is warmly acknowledged. Reciprocation resulted in collections being sent from Kenya to 17 countries. These included collections for inclusion in the U.S.D.A. and F.A.O. wheat nurseries, giving the Kenya material world-wide coverage.

Climatic conditions again played a major part in the results obtained, with regard both to disease and agronomic features. Early drought necessitated the use of irrigation and many plots did not recover from this early setback; the heavy rains of October and November resulted in sprouting and lodging in many lines and a severe build-up of leaf diseases in much of the later material. Stem rust at Njoro reached its usual high level through the use of susceptible spreaders artificially infected. However, the most significant point this year has been the appearance of the stem rust race which is able to attack derivatives with resistance from *T. timopheevi*. The loss is by no means complete, but considerable use is being made of *Timopheevi* lines as a source of resistance and it is disappointing that the effectiveness is already diminished.

Crosses and Accessions.—The Njoro-bred crosses and backcrosses made between 1956 and 1958 completed their period in the single plant culture stage and go forward to initial multiplication in 1962. The majority of this material is based on the *T. timopheevi* resistance of C.I. 12632 from Wisconsin and although a greater number of rusted lines were seen this year most of the material going forward for multiplication was unattacked.

The outstanding crosses in this group are: 1304=C.I. 12632×La Prevision[4]; 1204=C.I. 12632×Kenya 354P[3]; 1300=C.I. 12632×Kenya 294M[4]; 1205=C.I. 12632×Kenya 356[3]. A disappointment was severe rusting in Kenya crosses 1301 and 1197, both based on C.I. 12632 and Kenya 360H; they had been the outstanding material in this programme since its inception.

The double cross programme planted at Njoro suffered very severely from sprouting and lodging but through the repeat planting at Molo no material was lost. Outstanding crosses worthy of note for both stem and yellow rust resistance are:—

1336=(Colatana×Kenya 184P[3])×(Lee Frontana×Kenya 184P[2]).

1338=(Lee Frontana×Kenya 294M[3])×(C.I. 12632×Kenya 294M[3]).

1339=(Lagaedinho×Kenya 294M[3])×(C.I. 12632×Kenya 294M[3]).

The main bulk of Mexican and Colombian material, received between 1958 and 1961, has also reached the stage where multiplication can commence. This material is generally quick maturing and will produce varieties mainly suited to the lower and medium altitudes. Outstanding in this material are:—

(*a*) Lines based on Thatcher, Frontana and Cajeme 54 from Mexico.

(*b*) Lines based on C.I. 12633, Frocor and Gabo from Colombia.

The 1960 crossing programme was based on the *T. timopheevi* resistance of Wisconsin Supremo and Idaho 1887 and 1880, and also on the Minnesota wheats Frontana-Kenya-Newthatch and Mida-McMurachy-Exchange. Grown out of season the F_1 showed very great promise: planted again in the main season as F_2, the results were more variable. Severe infections of stem rust developed in the Frontana-Kenya-Newthatch material and wide segregation was seen in the crosses based on the *T. timopheevi* derivatives. Very heavy infections of blotch and leaf disease developed but the earlier lines, based on C.I. 12632 and Wisconsin Supremo, showed to advantage. Of oustanding general promise, including quality, were the following: C.I. 12632 and/or Wisconsin Supremo crossed to Mida-Kenya-Yaqui, Colombian II-3475, Veranopolis and the Kenya lines 1010 and 1016. Breeding lines from this new programme now reverse the picture of the last few years, as Njoro-bred material will outnumber material obtained from overseas nurseries and collections.

Breeding material at Molo has already been mentioned under double crosses but, of the other material being developed from high altitudes, the cross C.I. 7805 ×294M[3] is showing outstanding promise. (C.I. 7805 is of Ethiopian origin.) Much of the longer season material suffered severely from blotch and leaf disease; this was particularly illustrated in a number of crosses with 1066, where 1066×African Mayo was one of the few combinations to do well.

Accessions received varied in number from 2,000 lines from Colombia to four Durum varieties from Eritrea; limitation on space in this report means that mention can be made of only a few. The Colombian material was based on back-crosses to Frocor and Bonza, of which the Bonza lines showed most promise on rust resistance. As many of these lines are phenotypically very similar, a small "composite" of eight lines has been produced for evaluation next season. A range of Italian wheats revealed good resistance to stem rust in three varieties, namely Roma, Turaro and Tilchimar 12. The most important collection in the accessions was however a group of segregating lines from Australia. Those based on the cross Mengavi×(Spica-Koda×Gabo) showed very high levels of rust resistance and attractive agronomic characters in all but grain. The *T. timopheevi* resistance of Mengavi is supplemented by that from the other parents and this material is extremely promising.

Two programmes of crossing were carried out this year. In the first, 24 established parental varieties of good yield and high quality were crossed to four stem rust-resistant parents of *T. timopheevi* background combined with additional yellow rust resistance. In the second series, the aim was to broaden the range of rust resistance and re-combine a number of other stem rust resistances with that from *T. timopheevi.*

Nurseries.—International wheat, barley and oat nurseries were again grown; high disease scores were recorded and the barley and oat collections revealed nothing of future value. In the wheat nursery a number of Thatcher-based lines showed well and in all 20 extracts will go forward for further examination.

In the search for wider forms of rust resistance two new nurseries were grown. The World Collection of Wheat Species obtained from the U.S.D.A., Beltsville, proved to be of considerable interest and resistance was shown in *T. monococcum, T. dicoccum, T. macha* (winter types), *T. persicum* and *T. timopheevi.* In the Sando collection of Wheat×*Agropyron* derivatives (842 lines) rust scores for both stem and yellow rust reached very high levels. Throughout this material, segregation was extreme for both plant type and rust resistance, and although a number of clean lines were extracted they are generally widely divergent from the desirable bread-wheat type. The Inter-American Yield Nursery of 25 lines was received from Mexico but served only to confirm the virulence of the prevalent rust races on the entries concerned.

Initial Multiplication Plots.—There were 271 varieties in this stage of multiplication but the disappointing feature was the loss, due to stem rust, of the Idaho 1877 and 1880 selections based on *T. timopheevi.* In all cases tested the causative race was "40T". However, a number of very promising lines are being carried forward which have been selected from Mexican, Colombian and Minnesota collections.

Retrial of many promising Kenya lines is needed and will lead to a predominance of our own material at this stage in 1962.

Quality Tests

The past year has seen the inception of micro-tests at Njoro for assessments of wheat quality. Though the work has largely been exploratory so far, the progress achieved has been encouraging. The Zeleny lactic acid sedimentation test gave fair correlation with the dough strength values recorded in the laboratory of the millers (Unga Ltd.) on the Chopin alveograph, but not at the extremes of the range. Pelshenke dough-ball tests as now used extensively in Mexico were there-

fore tried as an alternative and have proved more satisfactory, giving a correlation of 0.92. Such tests were in fact carried out at Njoro in 1948, but discontinued due to staff limitations; the new work has been set up on a more mechanized basis and a considerable number of tests can be undertaken.

So far the tests have been applied mainly to the range of established varieties, as standards, and to new varieties coming forward in multiplication; these run parallel to the tests carried out by Unga Ltd. The real value comes from the extension of such tests to crosses under selection, and at their initial multiplication stage, so as to guide the choices that are being made on the field material. The need for rust resistance above all else must still dominate the selection of new wheats, but increased attention to quality is possible and encouraging results in these micro-tests show that the decision to develop this aspect of the work was timely and should make a significant contribution to the effectiveness of the breeding.

District Trials and Observations.—The 69 wheats at an advanced stage of multiplication were tested in a comprehensive programme of district trials in 1961. The unusual weather conditions adversely affected the trials at some sites; the plots at Rongai were killed by drought, while at Ol Joro Orok and Kinangop lodging and waterlogging resulted in complete loss. Results from Eldoret were outstanding and the variety Rushmore Surpresa from Dakota gave a yield of 19.97 bags per acre. At Kitale, blotch and leaf disease scores were very high; Salles-McMurachy-Exchange and three other new varieties did outstandingly well. Molo produced an excellent trial marred later by very heavy outbreaks of blotch and leaf diseases, and this also applied at the new high altitude site at Mau Narok. The most promising varieties at high altitude were II-53-357 and II-53-320 from Minnesota and, unexpectedly, the newly released Gala which had been issued for the lower areas. In general the trial results cannot be viewed too critically in view of the exceptional nature of the weather in 1961, and the absence of stem rust on most of the out-station sites. Nevertheless, some of the yields have been very encouraging, especially in a year when farm yields have been so low, and an extract of some of these yields is quoted in Table 4.

Field Multiplications.—There were 30 foundation and mother crops at Njoro and 10 at Ol Joro Orok. Attacks of stem rust caused the discarding of five Idaho selections as mentioned earlier and also the very attractive Brazilian variety Fonteleza. An unfortunate setback was suffered on three promising durum varieties (LD389, Yuma and Khapli D.C.×Carleton); the wet harvest conditions produced almost complete sprouting of the grain in the ears. Spare seed, sown out of season, is being used in replacement. The outstanding foundation crops were the Minnesota selections II-53-307, II-53-320 and II-53-370. Mother crops of Mexican 50187 B, Colombian II-3475, Gabo 54×Kentana-Rio Negro and Yaqui 53 all did well in spite of the adverse season. From these successful multiplications 12 varieties now go forward for pedigree stage multiplication with farmers in 1962.

Release of New Varieties.—Of the varieties in pedigree crop, Frontana-Kenya-Newthatch II-50-18 (283) and Kenya 504 F_5 Sel 4 were withdrawn due to rust attack; the durum RL. 3207 turned out to be badly contaminated with bread-wheat rogues. Frontana-Kenya-Newthatch-18 (194) and Kenya Research barley will be repeated at the pedigree stage due to the limited amounts of seed available after the difficult harvest.

Four varieties were released for 1962 of which the variety Kenya Jay is another of the "Bird" series. (*See* Table 5.)

TABLE 4—SOME YIELDS OF WHEATS IN TRIAL, 1961

Variety	Trial Yields (Bags per Acre)						Status for 1962
	Njoro		Eldoret		Molo		
	I	III	I	II	I	II	
Africa Mayo	—	—	—	8·94	—	9·40	Released.
Kenya 358	5·00	—	11·52	—	—	—	Released.
Mida McM Exchange	8·94	9·65	8·16	—	4·83	—	Released.
Veranopolis	6·34	—	14·49	—	—	—	Released.
Frontana x Kenya-Newthatch, II-50-25	7·09	—	11·16	—	4·41	—	Released.
Rushmore Surpresa	10·44	—	19·97	—	7·26	—	Released.
Kenya Grange	—	—	13·08	—	3·93	—	New Release.
Kenya Jay	—	—	—	—	12·23	—	New Release.
(Th x Sta Cat) Frocor	—	—	—	10·10	—	3·89	Pedigree Crop.
Salles McM x Mayo	—	—	—	7·80	—	8·19	Pedigree Crop.
Kenya 1016 P.1.	10·32	—	12·05	—	—	8·96	Mother Crop.
Kenya 1010 Sel 4.	9·57	—	11·91	—	—	5·10	Mother Crop.
Kenya 1016 P.2.	9·14	—	7·64	—	—	2·79	Mother Crop.
Kenya 1012 G.2.	9·23	—	13·32	—	8·46	—	Pedigree Crop.
Minn II-53-486	—	4·29	8·67	—	10·03	—	Mother Crop.
Mexican 50187 B	—	—	—	7·05	—	—	Pedigree Crop.
Columbian II-3475	—	—	—	5·01	—	—	Pedigree Crop.
Kenya 869 B.3.B.5.	—	—	—	—	12·89	—	Pedigree Crop.
Minn II-53-307	—	8·51	—	—	13·27	—	Mother Crop.
Minn II-53-320	—	8·74	—	—	12·52	—	Mother Crop.
Minn II-53-370	—	9·60	—	—	9·69	—	Mother Crop.
Highest Yield	10·44	9·65	19·97	11·37	13·27	9·40	
Lowest Yield	5·00	4·25	5·54	3·89	3·58	2·45	
Mean Yield	7·98	7·44	11·24	8·01	7·66	5·42	
Least Significant Differences at 5% level	1·41	1·42	3·75	4·96	1·69	1·65	

Notes

(1) Only those trials which survived the drought and weather to give reasonable results have been quoted; the choice of variety for quotation is arbitrary but covers those of general interest which yielded satisfactorily.

(2) The two sets of figures for each site represent results obtained in different trials.

(3) Two other new releases, Gala and Yaqui 50, ought to be recorded, but have been omitted; they are lower altitude varieties for which none of the sites quoted above was a fair test.

TABLE 5—RELEASES OF NEW WHEAT VARIETIES

Name	Pedigree	Altitude Range	Source
		Feet	
Gala*	II–3046–2b–3b–4b–6B = (Spring Wheat x Gabo) Lerma.	6–7,000	Colombia
Kenya Grange	599(L).4.A.1 = 360F x Granadero Klein	7, 5–8,500	Kenya
Kenya Jay	384/5 BJ.6.B.1 = Equator II x 318.AJ. 4.A.1.	over 9,000	Kenya
Yaqui 50	Marroqui 588 x Newthatch	6–6,500	Mexico

*Name adopted in Kenya with approval of Rockefeller Foundation, Colombia.

4. Breeding—Maize

Though the amount of maize activity at Njoro is quite small compared to the work on wheat, there has been interesting progress to report, especially in the field of synthetic varieties.

Synthetic I was released for 1957 and has been used successfully at Njoro and in the Subukia areas. Since then, Synthetic II has been formed but results in both 1960 and 1961 did not seem sufficiently attractive to justify its release. An interesting difference between these synthetics has now become apparent.

Under trial, at a moderate level of fertility, with adverse conditions from early drought, Synthetic II has outyielded I by five bags per acre, to yield 23 bags. The latter, however, is capable of yields in the 30-bag range if given fertile soil and good husbandry.

Meanwhile, components have been selected from Synthetic I (using II as tester) with which to form Synthetic III. Results of two years' trials seem to suggest that this next synthetic should exceed both I and II at moderate to lower levels of yield.

It seems probable that when further comparisons have been carried out each of the three synthetics may have advantage at its own level, in the order I, III, II, from high through to lower yield levels.

Work is also in progress on the evaluation of in-bred lines for hybrid maize; these are mainly in-breds developed from components used for the synthetics. Single crosses made this year should indicate those that may have sufficient specific combining ability for exploitation now in hybrid form.

B.—Report from Kitale

1. Review of the Year

This has been the second full season of the expanded West of Rift maize-breeding project and the second season of work at Kakamega. Steady progress continues to be made in the production of both hybrids and synthetics with two big advances to be noted for the year, details of which are given below. Trials were seriously affected by the unprecedented combination of severe "army worm", early drought, heavy hail damage and late excessive rain. Despite all this, the yield level has been reasonable, some trials have given highly significant results and most trials were brought through sufficiently well to be able to make decisions for practical breeding purposes. The breeding plots suffered little damage. The improved vigour and appearance of some of the in-breds, reflecting the work of past years, was very pleasing.

2. Breeding—Maize

Over 3,000 acres of Kitale Synthetic II were grown, mostly limited to 50 acres per farmer and mainly in the Trans Nzoia. For 1962 planting the variety is released from departmental control; seed is available through normal commercial channels, and the recommendations made for 1961 have been confirmed by a further year's trials and visits to farmers' crops. The synthetic is recommended for those fields in the Sotik and Trans Nzoia Districts together with adjacent areas of the Uasin Gishu where a yield of at least 15 bags per acre is expected. In the rest of the Uasin Gishu and in Nakuru District it is worth further trial in those few areas where high yields can be obtained. It is not recommended for medium or lower yield levels.

The two big advances, figures for which are given in Table 6, are increases in yield over Kitale Synthetic II of between 35 and 40 per cent for the first experimental single cross hybrids and predicted double cross hybrids, and increases of the same order of crosses to Kitale Synthetic II of two Central American varieties. The first small commercial plantings of the variety crosses are expected in 1963 and of double cross hybrids in 1964. Seed of the variety crosses will be cheaper but the disadvantage is in extremely tall plants as opposed to the hybrids which are very short and stand well.

The good crossing value to Central American maize makes possible a new departure, long hoped for, in the setting up of a reciprocal selection programme for yield increase.

TABLE 6—YIELDS OF THREE MAIZE HYBRIDS, 1961

Cross	Yield of Cross	Yield of Control (Synthetic II)	Least Significant Difference at 5% probability
	Bags/acre	*Bags/acre*	
Double Cross of Lines: MG60 (A x G) x (D x E) ..	28·6	21·0	4·4
Variety Cross: Ecuador 573 x Syn. II ..	40·1	29·2	4·2
Variety Cross: Coasta Rica 76 x Syn. II ..	24·1	17·0	2·6

Note.—In the case of the double cross, the yield data were obtained on single crosses in all combinations; the figure quoted above is that for the best double cross predicted from the working of the results from the single crosses.

Only brief mention can be given of progress achieved in other directions:—

(*a*) *Formation of Improved Kitale Synthetic II.*—Using the results of trials at three locations of 216 plant × plant crosses out of Kitale Synthetic, an improved Kitale Synthetic II will be formed in 1963.

(*b*) *Formation of Kitale Synthetic III.*—Using the results of trials at three locations of 42 top crosses of K58 first generation in-breds, selected from 100 top crosses in trial at two locations in 1960, Kitale Synthetic III will be formed in 1962.

(*c*) *Resistance to Puccinia sorghi.*—Considerable screening has provided four United States lines having apparent complete resistance to rust and a number of Central American varieties with a high level of resistance. The latter are probably of more use for our breeding programme as they have reasonable vigour.

(*d*) *Dwarfs.*—The variety U.S. 13, which carried the Brachytic II gene for dwarfness, has provided first back-cross lines to Kitale Synthetic II that have yielded well, with a cob that combines the large size of the Kenya parent with the high row number and deep grain of the U.S. Corn Belt maize. Originally it was thought we would have to go to second or third back crosses, but now, as well as continuing the planned programme, an attempt is to be made to put together a dwarf synthetic from the homozygous dwarfs that should appear in the best first back-cross lines selfed last year.

C.—Report from Machakos (Katumani)

1. Review of the Year

This was a year of tremendous contrasts. The severe drought of 1960 continued into 1961, a mere 7 in. falling between January and mid-October. Then came continuous torrential rain, causing widespread flooding and disrupting communications. A record total of 34 in. fell from mid-October to the end of the year; for figures *see* Table 1 in section A of the report. The maize crops harvested in Southern Province were exceptionally poor due to the prolonged drought, and record importations (including 147,000 bags of famine relief maize) had to be made.

Special attention was given to the problems of bulking and distribution of the new quick maturing maizes. In October, Taboran became available commercially and an encouraging number of small 5 lb. packets were sold to African farmers in dry areas. Bulking of Katumani Early Synthetic began at the Machakos Farmers' Training Centre.

2. Survey of Field Crops

The maize crops throughout the whole of Southern Province were extremely poor, and very low yields were obtained from the March and July harvests. World census figures for Machakos District (excluding Yatta and Kikumbulyu) give a total maize acreage of approximately 180,000 with an estimated yield of 0.8 bags per acre. The average trials yield of Taboran at Katumani and Kampi ya Mawe during 1961 was over four times this amount.

An increased acreage of sorghum and millet was sown in Machakos District during the year. The world census estimate for 1961 was 30,000 acres. This increase reflected the prevailing drought conditions which had continued on from 1960. Bird damage was considerably less than in previous years. Nevertheless the estimated yield was less than one bag per acre. Trials at Kampi ya Mawe showed that the quick maturing sorghum TADA could average seven bags/acre under precisely the same conditions, given adequate protection from birds.

3. Breeding—Maize

Trials confirmed the value of selection for earliness in obtaining drought-escaping maizes suitable for Southern Province conditions. The Agricultural Officer (Research), Katumani, was able to demonstrate experimentally that quick maturing crops conserved soil moisture, thus adding greatly to their known value as more reliable yielders.

Progress in the basic breeding programme for the production of quick maturing synthetic maizes was slow, due to the drought. Trials showed enormous variation because of differential wilting, and leaf diseases were largely absent, making selection impossible. Nevertheless, a new synthetic, Katumani Synthetic II, was formed during the year and is now in preliminary yield trial. This synthetic was made up from seven S_1 in-breds derived from Taboran × Local Yellow and Taboran × W341A crosses. In-breeding began in the Early Synthetic stock, but top-cross trials of the in-breds so derived were unsuccessful due to drought. These top-cross trials were repeated in the October sowings.

4. Breeding—Other Crops

Legume selection work was done in conjunction with the Agricultural Officer (Research), Katumani. Eighty single plant selections were made from a local cow pea variety. Selection was based on earliness, as judged by time to flowering. These selections appear to show considerable promise. Screening of coloured and white haricot bean varieties continued.

Trials of quick maturing and hybrid sorghums, the latter in conjunction with E.A.A.F.R.O., were put down. Both TADA and some hybrid sorghums from Israel yielded outstandingly well on a very low rainfall. Bulking of the "Hedgehog" bulrush millet, which shows some considerable degree of bird resistance, continued.

D.—Acknowledgements

In spite of the difficult year, all sections of the Plant Breeding Service have made pleasing progress. It is with much gratitude that we again record our appreciation of the help received from overseas. Gifts of material have been made most generously, and advice has been of considerable benefit too. The spirit of co-operation amongst cereal breeders throughout the world is of the very best and our thanks and good wishes go out to the many countries and staffs with whom we are in contact.

A word of special thanks is directed to the United States Department of Agriculture for the immense value of the International Nurseries of wheat sent out from Beltsville each year, and to the Rockefeller Foundation for their special grant to wheat research in Kenya. This latter comes on top of much help from their wheat and maize programmes in Central and South America in recent years, and is very much appreciated.

G. E. DIXON,
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ANNUAL REPORT OF THE PLANT PATHOLOGIST (PLANT BREEDING)

1961 was a year of consolidation rather than of major development, particularly as the Plant Pathologist was on overseas leave from March to September. During this time the work of race identification and varietal testing went on as usual but no attempt was made to launch new projects. On the other hand the opportunity of visiting rust research centres in North America, made possible by a grant from the Rockefeller Foundation, was very helpful in guiding the further development of the Plant Pathology Section.

Stem Rust of Wheat

The overall level of stem rust in the country was the lightest for several years and there was little serious damage from the disease. This was a little surprising as weather conditions were generally suitable for rust attack; the routine inoculation of infector surrounds in the breeding plots at Njoro produced a severe epidemic. The reason must therefore lie in a general lack of inoculum, and this can be attributed to the extreme severity of the preceding dry season, emphasizing the importance of carry-over from season to season on grasses and volunteer wheat. An extension of the investigations of this subject is now planned.

The number of collections of stem rust submitted to race identity tests was considerably reduced as compared with recent years though was still sufficient to give a reasonably reliable picture of race distribution; the results obtained presumably reflect the differential ability of the local races to survive a severe dry season. The results of the survey show a marked predominance of race 40, now divided into seven sub-races; of these, six occurred during 1961 and accounted for 56.1 per cent of the total collections. The only other race to appear in notable quantities was 295 at 20.3 per cent, while races 11 and 34 made up 5.5 per cent and 6.3 per cent respectively. The information on the relative frequency of occurrence of races is summarized in the table, together with the corresponding figures for 1959 and 1960 for comparison.

Table—Percentage Frequency of Stem Rust Races, 1959-61

Race	Number of Isolations (percentage of total)		
	1959	1960	1961
11	2·6	8·7	5·5
14	0·3	—	1·6
21	17·0	1·4	2·3
24	0·6	0·35	0·8
34	0·6	5·9	6·3
40A	12·0	6·6	3·9
40B	4·0	2·1	—
40C	24·0	15·7	14·0
40D	—	1·7	3·9
40E	—	11·2	9·3
40F	—	4·5	11·7
40T	—	0·7	13·3
42	23·0	3·8	2·3
143	10·0	3·8	0·8
184	0·3	0·7	1·6
189	6·0	18·5	—
295	0·6	14·0	20·3
296	—	0·35	0·8
297	—	—	1·6

Note.—In the table, two or more isolations of the same race from a series of experimental plots at a single site are treated as one record only. All isolations from farm crops are considered separately.

It will be noted that a further sub-race of 40 was identified during 1961, and this is a development of particular significance. Considerable attention has been paid in the breeding programme to the *Triticum timopheevi* type of resistance, which was effective against all the known races. Early in 1961 the commercial variety Wisconsin Supremo, with resistance based on *T. timopheevi,* was included in the differential series as a detector for new races able to attack this group. Such a race was very quickly detected and was found to be yet another variant of race 40 but with the additional ability to attack *T. timopheevi* lines. This new sub-race is now referred to as 40T. Rechecking of past records suggests that 40T was present in small amounts during 1960 and there is circumstantial evidence that it first appeared in the Northern Province of Tanganyika. An interesting and somewhat disquieting feature is the rapidity with which the new sub-race appeared when *T. timopheevi* lines began to be grown in quantity. On the credit side, 40T does not have the general virulence of some of the other sub-races, particularly 40C, nor does it attack the full resistance of *T. timopheevi* but only the derived varieties with a lesser degree of resistance.

The races 295, 296 and 297 are new to science and first appeared in 1959, 1960 and 1961 respectively. The very virulent race 189 did not occur during 1961.

As mentioned, the establishment of an artificial rust epidemic in the breeding plots was highly successful and enabled a satisfactory rust screening to be made. Further developments along these lines are planned for this coming season, using oil spray techniques in particular. A satisfactory rust epidemic was established on the trial plots of the Naro Moru short rains season.

The adoption of a number of new techniques towards the end of the year has led to considerable streamlining of greenhouse work. Another development of note is the use of small room air-conditioners to control temperature in plastic tents inside the main greenhouse. This has proved very satisfactory and under Kenya conditions is an excellent substitute for more elaborate and expensive growth chambers.

Yellow Rust (*Puccinia striiformis*)

The station again participated in the European Yellow Rust Trials and despatched information and rust samples to Europe. No attempt was, however, made to do race identification at Njoro, and with the present severity of the stem rust problem this work has low priority for the moment.

Oat Stem Rust (*Puccinia graminis avenae*)

Race identity tests on oat stem rust did not reveal any new races, but all four of those previously recognized were again present in 1961. These include races 6, 6A and 13A, the fourth race has now been recognized as 4A.

Other Diseases

Although rust levels were low during the year, exceptionally heavy rains at harvest time led to a build-up of several other diseases. None of these was new, but the very wet conditions enabled them to reach almost unprecedented levels and cause severe damage.

Glume Blotch (*Septoria nodorum*) is commonly present on wheat in Kenya, but production of fructifications is infrequent. Septoria Leaf Blotch (*S. tritici*) and Leaf Blight (*Pyrenophora* (*Helminthosporium*) *trichostoma*) are minor pathogens only, with fructifications normally limited to the imperfect stage. In 1961, however, all three diseases were present in severe epidemic proportions and all produced fructifications of their perfect stages in large numbers. Perithecia of *Pyrenophora trichostoma* were present on many grain samples. Scab (*Gibberella zeae*), Black Mould (*Cladosporium herbarum*) and Take-All (*Ophiobolus graminis*) were also exceptionally damaging during 1961, although Take-All symptoms were often masked by the presence of other parasitic and saprophytic fungi.

On barley, Net Blotch (*Pyrenophora teres*), Spot Blotch (*Cochliobolus sativus*) and Scald (*Rhynchosporium secalis*) caused heavy and often total losses. An unidentified species of *Pyrenophora* and at least two species of *Leptosphaeria* were also found and are being investigated.

The amount of inoculum of these diseases remaining in the soil on crop debris gives cause for concern in the coming season, and particular attention to seed dressing and other control measures has been advised.

On maize an event of note was the first record of *Helminthosporium carbonum* for Kenya, which occurred on a few in-bred lines at Kitale. An epidemic of Head Smut (*Sphacelotheca reiliana*) on swampy land in this area is causing concern as the lack of suitable alternative crops makes eradication of the disease difficult.

E. J. GUTHRIE,
Plant Pathologist.

ANNUAL REPORT OF THE COFFEE RESEARCH STATION, RUIRU

The year under review will be remembered for its contrast of drought and deluge. The first eight months were marked by poor rainfall and high temperatures after subnormal rainfall during 1960 throughout all districts East of the Rift. Good rainfall in September was a presage of the deluge which followed in the Short Rains. The rainfall pattern was similar in the Rift Valley and West of the Rift—very heavy following eight months of poor rains.

For the third successive year the trees carried an abnormal weight of early crop which drought brought to ripeness prematurely. In consequence, much of the crop was of poor size and quality. The late crop, harvested in the last quarter, was of normal size and quality; but continuous wet weather, throughout the peak of the harvest hindered natural drying and the complex processes needed for maintenance of quality.

Despite subnormal rainfall since September 1958, the infection levels of Leaf Rust and Coffee Berry Disease were sufficiently maintained to cause concern and loss of crop in the regions where these diseases are normally endemic. Prolonged wet weather from mid-October onwards provided ideal conditions for a rapid increase of both diseases, to a degree not encountered for many years. Even at lower elevations Coffee Berry Disease caused loss of crop at economic levels. By the end of the year, Leaf Rust outbreaks were general and severe, particularly in the lower zones.

Inches per Month	A	B	C	D	E	F	G	H
January ..	0·28	0·05	0·53	0·12	0·54	0·27	1·19	Trace
February ..	0·68	0·17	0·64	1·24	3·80	0·95	1·49	2·71
March	3·56	2·25	4·96	0·71	6·50	4·47	2·75	4·77
April	6·84	6·49	11·47	4·49	7·79	7·49	15·12	5·78
May	5·58	5·70	1·68	4·82	2·40	4·95	8·00	4·84
June	1·74	0·20	0·60	5·33	6·17	1·16	0·41	4·03
July	1·16	0·46	0·10	8·84	1·82	0·91	0·34	2·77
August ..	0·72	0·39	0·08	7·78	4·66	1·55	1·37	9·26
September ..	3·39	2·30	0·71	5·10	7·18	3·73	2·29	7·92
October ..	8·64	5·80	—	9·12	10·41	11·42	40·40	4·05
November ..	17·71	23·64	—	14·59	27·51	30·01	42·28	17·74
December ..	6·98	13·96	—	5·27	5·87	8·18	2·85	11·32
TOTAL ..	57·28	61·41	20·77	67·38	84·65	75·09	118·49	75·19
Number of days rainfall ..	153	125	47	182	227	163	128	192
Means and number of years ..	39·93 17	37·86 36	35·91 22	46·19 28	73·62 18	—	—	—

A = Coffee Research Station, Ruiru.
B = Scott Agricultural Lab., Kabete.
C = North Kitito Estate, Makuyu.
D = Kitale Experimental Station.
E = Kisii Coffee Research Sub-Station.
F = Upper Kiambu Coffee Research Sub-Station.
G = Mariene Coffee Research Sub-Station.
H = Koru Research Sub-Station.

In contrast to the severe upsurge of disease towards the end of the year, the whole period was notable for relative freedom from insect pest damage, particularly Leaf Miner. In June Dr. Bess, Senior Professor of Entomology at the University of Hawaii, concluded his nine month's attachment on a Fulbright Scholarship. During this time he completed a study of the integration of biological and chemical control, related chiefly to the bionomics of Leaf Miner. Some clear-cut conclusions were reached and the results of this intensive study have undoubtedly made a valuable contribution to a clearer understanding of the circumstances which affect Leaf Miner outbreaks. Another outstanding advance made during the year has been the evolution of a satisfactory bioassay technique for evaluating insecticides. Further advances were made in improving knowledge and perfecting controls for both major and minor pests of coffee.

In the field of Plant Pathology very good progress was made in two lines of investigation which are of particular interest to growers. Means of applying fungicides with full efficiency and at low volume constitute an aim of great economic significance. In their co-operative project Messrs Firman and Wallis showed that this aim can be achieved in the control of Leaf Rust. The study to determine the effect of fumigation of nursery beds with nematocide produced outstanding effects on the root system of coffee seedlings, although the cause and the practical implication of the results is not yet clear.

Three main projects constitute the major portion of the research programme in coffee physiology. It is now possible to trace the pattern of carbohydrate fluctuation in the tree throughout the crop cycle. Similar progress has been made in determining the influence of soil moisture availability on stomatal aperture. In the third project the cause of the "Crinkle Leaf" condition eludes discovery and study is now confined to the use of Captain as a control measure.

Field trials at the Makuyu Substation reached a point in 1961 where conclusive evidence had been obtained. A review of the future functions of the station led to a decision for its closure in September. Among a wide range of long-term cultural problems the study of tillage practice reached a conclusive stage during the year. After fifteen years the value of frequent weed control and the role of mulch and manure combination with tillage are now well established.

A long-term project for the breeding of coffee with particular reference to Leaf Rust resistance, was planned as a co-operative undertaking with the Coffee Research Station, Lyamungu, Tanganyika.

Coffee Processing Research has continued on the lines pursued in 1960. Work on ventilated conditioning bins and their utilization was brought to a successful conclusion. A first stage dryer was developed by Mr. Johnson, Agricultural Engineer at Nakuru, and was subject to a series of evaluation tests to determine suitable methods of operation. Officers of the East African Industrial Research Organization have continued their work on several aspects of processing. Mr. A. E. Wootton successfully concluded his study of "onion flavour". Dr. B. N. Ghosh undertook investigations of several aspects related to the mechanical handling of coffee.

A fully detailed record of all research undertaken during the year is included in a separate report covering the 1961/62 crop year. As in previous years, copies of this report published in July 1962 are obtainable from Coffee Research Station, Ruiru.

P. A. JONES.
Senior Research Officer.

ANNUAL REPORT OF THE ENTOMOLOGISTS (COFFEE SERVICES)

The year was remarkable for the small amount of damage done to the coffee by insect pests. In particular, the widespread outbreaks of Leaf Miner which have occurred regularly in the latter months of every year since 1954 did not materialize in 1961. This failure appears to be due to the heavy rains killing larvae and adults.

LEAF MINER *Leucoptera meyricki* Ghes. and *L. caffeina* Washb.

Professor Bess (Fulbright Scholar) completed his study of the integration of biological and chemical control of Leaf Miner in June. His main conclusions were—

(i) that the insecticides currently used for Leaf Miner control do not affect the host/parasite ratio ; and

(ii) that correct timing of the sprays was of prime importance if a worthwhile degree of control is to be achieved.

He is now writing up his work in detail and it will probably appear in print in 1962 or 1963.

A bioassay technique for evaluating insecticides, using Leaf Miner as the test insect, has been successfully evolved. Adult moths are caged on trees in the field for oviposition. Leaves bearing eggs are picked when the eggs are at the point of hatching and are kept at high humidity and constant temperature until the larvae have reached the third instar. The leaves are sprayed in a Potter Tower and kept for three days in an air stream at high humidity. The mines are then opened and live and dead larvae are counted.

Using these techniques the following results have been obtained:—

(i) Seventeen new insecticides have been screened. Three showed sufficient promise to be put into field trials.

(ii) Parathion and diazinon appear to be absorbed into the leaf lamina and act mainly as stomach poisons. They are equally effective whether applied to the upper or lower side of the leaf.

(iii) Sprays made up from emulsifiable concentrate formulations are more effective than those, containing an equal concentration of insecticide, made up from wettable powder formulations.

(iv) The addition of extra wetters improves the performance of most of the commercial formulations available in East Africa.

(v) At laboratory temperatures *L. caffeina* is more easily killed than *L. meyricki*.

Many of these points require confirmation in field trials before revised recommendations for the control of Leaf Miner can be issued.

Technical parathion has been formulated in the laboratory and a dosage mortality curve for *Leucoptera meyricki* has been determined under controlled conditions. It will now be possible to detect the development of resistance of *L. meyricki* to parathion at an early stage, should it develop in future.

A detailed study of the population dymanics of *L. meyricki* was begun in August. This involves measurement in the field of fecundity and fertility and assessment of the natural mortality occurring in different stages of the pest at different times of the year. These counts are being supplemented with work on the biology of the more important parasites. It is hoped that these studies will lead to an understanding of the mechanisms of outbreaks, a problem intimately connected with the control of the pest.

Antestia *Antestiopsis lineaticollis* Stal

It was found that with an efficient knapsack sprayer, Antestia could be controlled by low volume sprays of pyrethrum supplemented by five per cent D.D.T. dust on the trunk. The spray volume was cut by a quarter to 20 gallons per acre. It was necessary to double the pyrethrum concentration to 0.012 per cent pyrethrins. The amount of pyrethrum needed per acre is therefore only half that needed for a high volume sprays.

Breeding of Antestia bugs in the laboratory for insecticidal work continued. Several modifications were made in the breeding technique during the year to reduce mortality in the early instars.

Leaf Eating Caterpillars *Ascotis reciprocaria* Wlk. and *Parasa vivida* Wlk.

The looper caterpillar *A. reciprocaria* was recorded on coffee for the first time in Kenya. It caused considerable defoliation on estates in the Ruiru and Mitubiri areas. The main features of its life history were worked out in the laboratory. It proved very difficult to control. Organo-phosphorus insecticides, when used at concentrations normally recommended, gave a poor kill. Lead arsenate at the standard rate of 2½ lb. per acre gave a negligible kill after four days. Only sprays of D.D.T. and the pyrethrum/D.D.T. treatment developed for Antestia control gave a satisfactory kill.

Laboratory and field observations were also made on the Stinging Caterpillar *P. vivida*. The length of the life history is very variable due to pre-pupal diapause which may last some months in Kenya. Though not recorded feeding on coffee in the areas west of the Rift Valley, several adult moths have been taken by different collectors in those areas.

Other Investigations

Field studies of the Lacebug *Habrochila ghesqueirei* Schout. continued. In laboratory tests parathion was found to kill the eggs at concentrations lower than those used in the field. There have, however, been no suitable infestations on which this finding can be checked.

Trees affected in varying degrees by root mealybug *Planococcus citri* Risso were given a soil treatment with 2.5 per cent aldrin dust. Trees which had yellow wilted leaves recovered but those on which all leaves were brown died despite the treatment. This experiment will have to be repeated in a year when the rainfall is less favourable to the recovery of the wilted plant.

Some observations were made on the biology of the large coffee tortrix with the green caterpillar *Archips occidentalis* Wlsm. This species, however, is only common at altitudes lower than Ruiru and most of the few that could be collected at the Coffee Research Station proved to be parasitized.

New Records

Apart from *Ascotis reciprocaria* noted above, there were records of two new coffee pests in 1961. A species of woodlouse, as yet unidentified, attacked seedlings in a Ruiru nursery. Small pieces were eaten out of the root cortex. Some roots were ringed completely and the affected seedlings died.

Fruit-piercing moths attacked large green berries on several estates in the Makuyu-Mituburi area. At least three species were concerned, *Othreis materna L., Calpe provocans* Walk. and *Cyligramma latona* Cram. Punctured berries ripened prematurely—in many cases before the beans had fully matured. A poison bait of pineapple soaked in diazinon gave variable results.

Publications

Work on Star Scale *Asterolecanium coffeae* Newst., White Waxy Scale *Ceroplastes brevicauda* Hall and Yellow-headed Borer *Dirphya nigricornis* Ol. has been written up for publication.

P. E. WHEATLEY,
Entomologist.

T. J. CROWE,
Entomologist.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (INVESTIGATIONS)

Makuyu Substation (North Kitito Estate)

The original work on this substation started in 1938 but was soon interrupted by the war. A new programme of investigations was intiated in 1953 with the planting of a variety trial and concluded in 1961 when the substation was closed.

Variety Trial

The variety trial consisted of six selections which were replicated five times in twenty tree plots. The first crop was permitted in 1956 when the mean yield for the trial was ¾ ton of clean coffee per acre, with the heaviest crop from SL 28 (17.94 cwt.). This variety maintained its position in all years except 1959 and, even in that season, was not significantly inferior in yield to any of the other varieties.

Table (*a*)—Makuyu Variety Trial, 1956–1961

Mean annual yields in cwt. clean coffee per acre.

SL 28	11·78	Co-efficient of Variation	8·68%
Meru Kents	10·04	Least Significant Differences:	
S.L. 14	9·72	p = 0·05	1·12
SL 9	9·43	p = 0·01	1·53
K7	9·20	p = 0·001	2·07
Kenya Selected Series "A"	8·46		
General Mean	9·77		

It is concluded that SL 28 has out-cropped all other selections and Kenya Selected Series "A" has yielded significantly less than SL 28, Meru Kents and SL 14. At planting time treatments were superimposed to ascertain the effect of nitrogen, phosphate, potash and cattle manure upon establishment and early growth. The NPK addition led to death of plants at 1—3 months after initial establishment, probably due to very dry conditions and the effect of potash in the planting holes. Cattle manure was very clearly beneficial in its effect upon early growth of seedlings.

Copper Spray Trial

A second important trial was begun in 1954 to determine the correct time at which to apply copper fungicide to reduce the premature loss of leaves. In all cases the concentration of chemical was 6.8 lb. of a 50 per cent copper fungicide per 100 gallons of water and approximately 1 pint was applied to each tree. The exact volume was varied according to the average size of the trees each year. The three times studied were—early in the long rains (usually the first week in April), late in the long rains (usually the last week in May) and early in the short rains, which was generally the first week in November. The first crop was recorded in 1955 when the coffee sprayed late in the long rains yielded 3¼ cwt. of clean coffee more than the unsprayed trees. As the trial continued, the early long rains treatment became progressively superior to the other two spray timings. This was particularly noticeable in the 1959 yields. It appeared that the spray in April 1958 had had a marked effect in reducing the attack of Leaf Rust which developed later that year.

TABLE (*b*)—MAKUYU COPPER SPRAY TRIAL, 1955–1961

Mean annual yields in cwt. clean coffee per acre.

		%
No Spray	5·84	100
Early Long Rains ..	8·19	140
Late Long Rains	7·77	133
Early Short Rains ..	6·72	115
General Mean ..	7·13	

Co-efficient of variation 6·88%

Least Significant Difference:

p = 0·05	0·78
p = 0·01	1·13
p = 0·001	1·66

These results indicated quite clearly that all spray treatments have raised yields considerably, that the long rains is the most important time to spray, but that over seven seasons there is little difference between applying the fungicide early or late in the rains. The early long rains spray treatment raised the mean annual yield by 2.35 cwt. of clean coffee per acre. There is no other coffee cultural practice known which will produce a 40 per cent yield increase for so small an expense as is represented by one fungicide spray a year.

COFFEE RESEARCH STATION, RUIRU

Weed Control.—The importance of weed control during each wet season has been studied for fifteen years. It is now well established that good weed control is essential, although the reasons for the great responses to weeding are not fully understood. The conservation of moisture during the rains for use by the coffee during the dry weather is certainly important, but the competition for nutrients between the coffee and the weeds also contributes to the results. Further information on the latter aspect is shown in Table (*c*) for the ten seasons 1952-1961.

TABLE (*c*)—CULTIVATION TRIAL, 1952–1961

Mean annual yields in cwt. clean coffee per acre.

TREATMENTS	ANNUAL APPLICATIONS OF CATTLE MANURE PER TREE				Means for Weeding Treatments
	Nil	1 x 4 gall. tin	Response	Statistical Significance	
Clean weeding ..	8·80	9·34	+0·54	N.S.	9·07
Weeds slashed ..	7·24	8·00	+0·76	p = 0·05	7·62
Tall weeds	5·40	6·45	+1·05	p = 0·01	5·93
Means	7·15	7·93	+0·78	p = 0·01	7·54

Athi plains cattle manure did not raise the yield of coffee kept free from weed competition, but the mean annual response to manure on the "tall weeds" plots was approximately 1 cwt. This result can also be considered as a partial compensation for weed competition by the provision of nutrients in the manure. The results suggest that of the 3.40 cwt. response to weeding on the unmanured plots approximately 2.35 cwt. can be attributed to better moisture conditions and 1.05 cwt. to the elimination of the competition for nutrients between the coffee and weeds.

Multiple Stem Pruning.—An experiment was begun in 1957 to study in detail the pruning of multiple stem coffee. The trial was sited on coffee planted in 1956, from which three crops have now been harvested. The main treatments and the mean annual yields for 1959-1961 are summarised in Table (*d*).

TABLE (*d*)—PRUNING TRIAL, 1959–1961

Mean annual yields in cwt. of clean coffee per acre.

2 HEADS PER TREE	PRUNING OF PRIMARIES				
PRUNING OF SECONDARIES	Cut up to 2 nodes above "break"	Cut up to "break"	Cut up to 2 nodes below "break"	Cut up to 4 nodes below "break"	Means
Only secondaries on inmost 18″ removed	10·24	8·43	8·79	10·68	9·54
Maximum of 4 secondaries bearing per primary ..	9·95	9·33	10·79	10·89	10·24
All secondaries removed at pruning	9·32	8·03	9·51	10·83	9·42
Secondaries removed throughout the year ..	8·37	9·93	7·83	8·75	8·72
Means	9·47	8·93	9·23	10·29	9·48

Least significant difference:	Within the tables:	Between marginal means:
p = 0·05	1·69	0·85
p = 0·01	2·33	1·16
p = 0·001	3·18	1·59

It is interesting to note that the wide range of the lengths of head from about 3 ft. to 4½ ft. had little influence on the level of cropping. Where no secondaries were permitted the yield was significantly less than from trees with up to four bearing secondaries on a primary branch. From a consideration of the results so far, it appears that approximately 4 ft. of bearing wood can be left on each head and that at pruning up to four secondaries can be permitted on any one primary. During the remainder of the year secondaries should not be removed except for keeping the centre of the tree open. This may be achieved by removing secondary growth arising within 1 to 1½ ft. of the main stems.

J. A. N. WALLIS,
Agricultural Research Officer.

ANNUAL REPORT OF THE AGRICULTURAL RESEARCH OFFICER, COFFEE LIAISON (AFRICAN DISTRICTS)

Coffee Vaviety Trials in African Areas

Valuable information was obtained from the various Leaf Rust (*Hemileia vastatrix*) Exposure Trials during 1961. The "S" Varieties S288, S333 and S795, obtained from the Coffee Research Station, Balehonnur, continued to exhibit immunity to Races I and II of Leaf Rust. Sufficient coffee cherry was harvested from each of the selections to prepare samples for liquoring and quality assessment. Unfortunately, the liquoring quality of these selections has been disappointing when compared with high quality Kenya varieties, such as SL28 and SL34. The liquors of the "S" varieties were considered to be atypical of good Kenya coffee and were generally lacking in acidity, body and satisfactory flavour. Yields were generally low, although these varieties were not attacked by Leaf Rust and carried sufficient leaf.

The "S" selections grown from seed have shown considerable variability in field trials; consequently, one acre blocks of S288, S333 and S795 have been established at the Mwea Irrigation Research Station (altitude 3,900 ft.) in Central Province. It is intended to re-select for high potential yield and good liquoring qualities.

At Kamagambo, South Nyanza District, (altitude 4,800 ft.), the Indian selections BA8, BA10 and BA16 have grown exceptionally well and will produce a considerable crop in 1962. Information anent the liquoring qualities of these varieties should be obtained during 1962, but considerable tree to tree variation within each BA selection has been noticed. Re-selection work will probably prove necessary before release for commercial use.

The high quality varieties SL28 and SL34 are now planted extensively throughout the Central and Southern Provinces. In variety trials SL28 and SL34 continue to show their superiority over other varieties wherever Leaf Rust and Coffee Berry Disease (*Colletotrichum coffieanum*) are absent or of minor imopratance. In areas where only Race II of Leaf Rust occurs, the varieties SL6 and K7 are outstanding, as both these varieties are immune to Race II of Leaf Rust. A suitable variety, with high yield and quality, has yet to be found for areas where Races I and II of Leaf Rust are endemic.

B. HANGER,
Agricultural Research Officer.

ANNUAL REPORT OF THE PLANT PATHOLOGIST (COFFEE SERVICES)

Leaf Rust

The main work of Leaf Rust (caused by *Hemileia vastatrix*) has been a series of field trials and investigations designed to determine if the disease could be controlled by using volumes of spray lower than those currently recommended. Current recommendations involve the use of 7 lb. of a 50 per cent copper fungicide in 60-80 gallons of water per acre. Using both motorised knapsack mistblowers and tractor mounted air assisted sprayers, the control of Leaf Rust achieved by a wide range of volumes and concentrations of fungicide has been investigated. The amount of copper deposited on the leaf surfaces has been studied in relation to these volumes and concentrations.

A preliminary trial, using a knapsack mistblower, established that, where spray was applied individually to each tree, satisfactory disease control could be achieved with 4 gm. of fungicide in 50 ml. of spray fluid per tree. A further trial investigated a wide range of spray volumes and concentrations and it was finally concluded that such a machine could be used at approximately 10 gallons per acre. At this volume 6 lb. per acre of a 50 per cent copper fungicide was necessary to achieve an adequate copper dosage. It was found that a dosage of at least 60 mg. Cu. per square metre of leaf surface was necessary for good control, but the variability of the spray deposit was very high. If this variability can be reduced it seems likely that somewhat lower mean copper deposit will suffice. Also, in these trials only one pre-rains spray was applied. In normal practice a further spray is applied some 3-4 weeks after the beginning of the rains. Thus, where two or more sprays are applied, the possibility of reducing the concentration in each arises. Although practical limitations make it unlikely that the volume can be reduced further, there is however the possibility of further reduction in quantity of fungicide. This aspect of the problem is also receiving attention.

Following the success of the trials with knapsack sprayers, the work was extended to the use of tractor mounted sprayers. It was again shown possible to reduce the volume considerably and, for practical purposes, 20 gallons per acre was the most satisfactory rate. A further trial was designed to determine the optimum quantity of fungicide to be used in this volume. It was again found that, using a single pre-rains spray, at least 6 lb. of a 50 per cent copper fungicide per acre was necessary to give adequate disease control.

Soil Fumigation

Work on the use of soil fumigation to overcome the decline in seedling vigour associated with the repeated use of coffee nurseries has continued. The preliminary trial, using "D.D." in the Coffee Research Station nursery, has been completed and very striking growth responses have been observed. Seedlings of 18 months old from the fumigated beds showed a two-fold increase in dry weight and total leaf area, and a three-fold increase in the length of the tap root. Apart from the length of the tap root, there was a very marked difference in the whole root system and the stubby much branched root system, typical of the plants from unfumigated beds, was replaced by a much more extensive system of finer and less branched roots. Despite the obvious efficiency of this root system in producing very much improved aerial growth, it poses a problem with regard to transplanting the seedlings into the field and, because of this, soil fumigation is not of immediate practical application.

Detailed investigations into the nematode population of coffee nurseries are in progress, but so far no particular species has been implicated as a cause of the stubby root system and seedling decline. In contrast to experience of similar troubles in other countries, the genus *Pratylenchus* does not appear to be involved. The work is being extended to cover comparative fumigant trials, detailed observations on root growth, transplanting of seedlings and site fumigation in the field, and investigations into possible causes of growth improvement following soil fumigation.

Stem Pitting

Work on the symptoms and incidence of Stem Pitting in Kenya has been written up and accepted for publication.

Elgon Die Back

Field experiments in the Trans Nzoia and Elgon Nyanza have indicated that copper sprays at the times recommended for Coffee Berry Disease control can significantly reduce the number of branches affected by Elgon Die Back. Despite this, the degree of control effected cannot be considered as satisfactory. These experiments will be continued to elucidate further the practicability of chemical control.

I. D. FIRMAN,
Plant Pathologist.

ANNUAL REPORT OF THE PLANT PHYSIOLOGIST (COFFEE SERVICES)

Carbohydrate Studies

The experiment designed to study levels of carbohydrates in various parts of the coffee tree was continued throughout the year. The last samples were taken in December but the analysis is not yet complete.

The results of the chemical analysis obtained to date are in agreement with the observations on the quantity of starch as measured by visual means. Using the latter method, observations were made on branches of multiple-stem trees bearing a crop resulting from a concentrated flowering in November 1960. The amount of starch present was closely related to the growth of the berries. As soon as the berries pass the pinhead stage and start growing, the quantity of starch drops to a low level. Approximately 16 weeks after flowering, growth of the berries comes to a temporary standstill and the amount of starch in the branches increases again. When the berries resume their growth, the level of starch reaches another minimum. Favourable weather conditions enabled the trees to recover rapidly after the crop had been picked. This, added to the earliness of the crop, ensured that ample starch supplies were available at the time of the short rains, 1961, flowering. This is in marked contrast to 1960, when dry weather delayed ripening of the crop and made the conditions for photosynthesis unfavourable. In that year, the level of starch some time before flowering was considerably lower than in 1961. Starch in non-cropping branches of a cropping tree fluctuates in the same way as starch in the cropping branches, proving the interdependence of the various parts of the tree, but it does not reach the same low minima.

Old wood from which the secondaries were constantly removed showed a much lower quantity of starch than similar primaries on which non-cropping secondaries were left. There is, however, a suggestion that too high a density of secondaries is not an advantage. Build-up of starch in secondaries happens quickly and there seems to be no reason to believe that they drain the resources of the primary as long as they do not carry a crop.

Growth of the Berry

After a period of approximately seven weeks in the pinhead stage, vigorous growth occurs in the period of approximately 7-16 weeks after flowering. At the end of this second period, the final size of the beans is determined. It seems that soil humidity acts strongly in this period, but on the fresh weight only and not on the dry weight. After reaching maximum size, the berries do not increase in weight for about two weeks. Then, a continuous accumulation of dry matter helps to fill the beans. When the beans have reached their maximum dry weight (about five weeks before the berry is fully red) the pulp begins to change colour. While the pulp is ripening, it increases considerably in dry weight; according to observations, as much as 100 per cent.

Water Relations

Growth recording done in the Irrigation Trial showed a considerable increase in branch elongation as a result of irrigation in dry periods. Differences in growth over a full year were, however, very small.

Measurements of stomatal aperture carried out in the same trial showed that, as might be expected, a low soil humidity has a limiting effect on stomatal aperture. Stomatal aperture is negatively correlated with temperature, while nitrogen applications stimulate aperture increase.

THE "CRINKLE-LEAF" CONDITION

Applications of 4½ lb. of Captan in 200 gallons per acre at the time when the very first symptoms of the Crinkle Leaf condition appear resulted in a practically complete control. Repeated spraying is essential, however, to suppress the condition completely; e.g., in the long rains 1961, three spray applications were needed at intervals of 6 weeks. Work is in progress on rates and concentration of sprays, their timing and possible secondary actions.

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Plant Physiologist.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST (COFFEE SERVICES)

CHEMICAL—COMBINATION OF THE *P* DIGESTION AND DETERMINATION WITH K, Ca, Mg DETERMINATIONS:

Two different methods have been employed in the laboratory, one for the determination of phosphorus and another for potassium, calcium and magnesium. The phosphorus method involves digestion with a mixture of nitric, sulphuric and perchloric acids (Piper's method). The method for K, Ca and Mg involves ashing in a muffle furnace, followed by hydrochloric acid digestion. It has now been found that the digest used for phosphorus determination can also be used for the determinations of the other elements; a valuable and time-saving discovery.

TABLE I—ANALYTICAL METHODS COMPARED

											Mean
% Mg	(*a*)	·25	·45	·40	·22	·25	·17	·16	·46	·45	0·44
		·17	·40	·50	·19	·33	·40	·18	·28		
in dry matter	(*b*)	·24	·44	·40	·21	·24	·17	·16	·42	·49	0·43
		·16	·41	·56	·20	·30	·33	·16	·29		
% Ca	(*a*)	1·49	1·40	1·38	1·64	1·45	1·90	1·40	0·98	1·30	1·39
		1·61	0·98	1·16							
in dry matter	(*b*)	1·48	1·30	1·54	1·64	1·23	1·86	1·34	0·93	1·30	1·35
		1·54	0·92	1·13							
% K	(*a*)	2·42	2·61	2·42	2·33	2·38	2·74	1·80	1·83	2·14	2·24
		2·05	1·99	2·17							
in dry matter	(*b*)	2·43	2·58	2·44	2·38	2·44	2·70	2·03	2·09	2·05	2·27
		2·18	2·00	2·20							

(*a*) = Ashing method.
(*b*) = Wet acid digestion.

LEAF PHOSPHORUS:

Leaf samples analysed from various trials at the Coffee Research Station have shown that water availability has a great influence upon leaf phosphorus values. Results obtained from the mulch/soil regeneration trial and manurial trial IV, for leaves sampled in 1960, are shown in tables II and III respectively. The effect of grass mulch in raising the mean leaf phosphorus in both young and old leaves is shown in Table II.

TABLE II—PHOSPHORUS CONTENTS AS PERCENTAGE IN LEAF DRY MATTER

Nitrogen Treatment	Nil	Sodium* Nitrate	Ammonium Sulphate* Nitrate
1st Mature leaves—			
No mulch	0·1236	0·1241	0·1296
Napier grass mulch	0·1641	0·1512	0·1523
Leaves from 2nd node with cherry—			
No mulch	0·0874	0·0876	0·0874
Napier grass mulch	0·1722	0·1454	0·1463

* 46 *lb. N applied annually in April.*

TABLE III—PHOSPHORUS CONTENTS AS PERCENTAGE IN LEAF DRY MATTER

	No Mulch	Napier Grass Mulch (Alternate row)	Napier Grass Mulch (In row)
1st Mature leaves	0·1378	0·1491	0·1530
4th leaf samples	0·1314	0·1359	0·1453
1st and 2nd node with cherry ..	0·1108	0·1172	0·1260

In Table IV, mean leaf phosphorus values (4th leaf samples) for Manurial Trial IV and the Irrigation Trial (overhead irrigation applied whenever necessary) are presented. The effect of irrigation has been to maintain high leaf phosphorus values over the whole year, including the dry period. During the rains phosphorus levels are found to be high with or without either mulch or irrigation.

TABLE IV—PHOSPHORUS CONTENTS AS PERCENTAGE IN LEAF DRY MATTER

	March–June	July–Oct.	Nov.–Dec.
Rainfall in inches	21·83	4·95	8·89
No Mulch	0·1456	0·1018	0·1620
Napier grass mulch (Alternate row) ..	0·1471	0·1156	0·1539
Napier grass mulch (In-row)	0·1570	0·1212	0·1703
No irrigation—			
−N	0·1497	0·1312	0·1776
+N	0·1311	0·1136	0·1656
Irrigation—			
−N	0·1597	0·1547	0·1880
+N	0·1558	0·1278	0·1852

Results given in Tables II and IV show that the presence of nitrogen fertilizer has tended to lower the phosphorus levels in the leaf.

LEAF NITROGEN:

The mean leaf nitrogen values for the 1st mature, 4th leaf pair and 2nd node-with-cherry samples from Manurial Trial IV and those from the Irrigation Trial (4th leaf pair samples) are presented in Table V.

TABLE V—NITROGEN AS PERCENTAGE DRY MATTER: MEAN OF THREE TYPES OF SAMPLE

	March–June	July–Oct.	Nov.–Dec.
Rainfall in inches	21·83	4·95	8·89
No Mulch	1·970	1·554	2·026
In-row mulch	2·029	1·719	2·135
No Irrigation—			
−N	2·007	1·701	1·946
+N	2·061	1·802	1·971
Irrigation—			
−N	1·936	1·802	2·002
+N	1·934	1·836	2·024

In general, mulching has maintained higher leaf nitrogen levels than the control, particularly during the dry period. Nitrogen fertilizer alone, and irrigation with or without nitrogen fertilizer, have apparently raised leaf nitrogen levels over the control during the dry period.

LEAF MAGNESIUM:

Leaf magnesium levels in Manurial Trial VI were found to be generally high. Annual application of 40 lb. magnesium per acre failed to raise leaf magnesium in the 4th leaf samples, but raised significantly the values in the dry matter of 2nd node-with-cherry samples from 0.42 per cent to 0.47 and 0.45 per cent respectively, when applied as magnesite or Kieserite.

MICRO-NUTRIENTS:

Leaf samples from the Coffee Research Station and Substations have been analysed spectrographically for the last two years. The mean values are similar to those obtained from trees grown in other countries such as Brazil.

(Medcalf, J. C. and Lott, W. L. Metal Chelates in Coffee, I.B.E.C. Research Inst. Bulletin No. 11).

TABLE VI—LEAF MICRO-ELEMENT VALUES

Elements in ppm	Iron	Manganese	Boron	Zinc
Upper Kiambu, unshaded	181	111	47	14·2
Upper Kiambu, shaded	180	167	45	11·4
Kitale, shaded	180	205	50	11·5
Kitale, shade and mulch	183	156	58	21·3
Ruiru, (C.R.S.) mulched	220	210	76	11·8
Ruiru, (C.R.S.) unmulched	192	812	85	8·6
Koru, unshaded	147	161	60	15·2
Koru, shaded	170	184	51	9·6
Kisii	170	180	71	9·0
North Kitito	135	218	39	10·5

It appears that shade leads to an increase in leaf manganese and a reduction of leaf zinc. Mulch has apparently raised leaf zinc and, in presence of shade, has reduced leaf manganese.

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ANNUAL REPORT OF THE GRASSLAND RESEARCH TEAM

Review of the Year

Progress has been made at Kitale in the improvement of Rhodes grass, by the selection and development of a more leafy and stoloniferous type which flowers much later than other varieties in current use.

In the fertilizer investigations on lucerne, further responses have been obtained to sulphur and also to potassium, calcium and magnesium. On Rhodes grass, similar results have been obtained, showing the need for comprehensive fertilizer treatment if good yields are to be maintained in grasses and legumes.

In the evaluation of pastures by means of animal production, useful information has been gained on the amount of milk obtainable from a setaria pasture.

In the pasture chemistry investigations, the programme consisted of interpreting past data on the chemical composition of plants, and of obtaining further information on the chemical changes which occur in them from early growth to maturity. The patterns of change in the crude protein content of pastures required for milk production have also been studied on three experimental stations throughout the year.

With the departure of the Pasture Research Officer from Katumani, the completed experiments there are being written up for publication. All the long term experiments on natural grassland have continued, and certain recordings made during the long rains show no significant variation in the trends already recorded.

With the transfer of the Pasture Research Officer at Marigat to Katumani, the scope of the work at Marigat has been reduced. At Marigat the re-seeding experiments have now terminated. Complete cultivation with a rigid tine harrow has proved most successful as a seed bed preparation on the denuded red soils of the Baringo plains. *Cenchrus ciliaris, Eragrostis nr. curvula* and *Enteropogon macrostachyus* are all promising grasses for re-seeding work. Reduction of the bush population and control of regeneration is a bigger problem than re-seeding. Work shows that the "Holt" bush-breaker will not kill any species unless combined with other treatments.

The Chepararia variety of Rhodes grass, under irrigation, gave 24.9 tons of dry matter per acre without any fertilizer, which indicates what the possibilities are when good grasses are suitably managed.

At the Molo Grassland Station, the major effort has been directed towards better regeneration of subterranean clover, which has given very good results at that station. A dressing of about 200 lb. an acre of triple superphosphate has given the best result so far, having increased the grass-clover production nearly six-fold compared with the control.

Grassland Research Station, Kitale

(1) Weather and Rainfall

The early part of the year was exceptionally good for planting purposes, in fact it was ideal. The latter half of the season was abnormally wet, but not excessively wet. The rainfall for the year was an all-time record.

Month	1961		1960		1951–1960
	Inches of Rainfall	No. of Wet Days	Inches of Rainfall	No. of Wet Days	Ten-year Means in Inches
January	0·07		0·74	6	1·027
February	0·83	5	1·11	8	1·496
March	1·43	6	8·22	19	3·356
April	5·87	13	3·09	17	5·325
May	5·45	16	3·47	19	5·858
June	5·98	15	2·66	15	4·544
July	7·94	20	5·86	23	4·322
August	8·88	20	7·67	20	6·163
September	4·76	14	5·31	17	3·669
October	8·77	22	1·52	15	3·434
November	12·13	25	1·02	14	2·042
December	5·89	10	1·80	9	1·828
Total	68·00	166	42·47	182	43·065

(2) Plant Introduction and Preliminary Grazing Trials

In the introduction nursery, *Trifolium mattirolianum* from Ethiopia, *Cynodon dactylon* from the Kiambu District in Kenya and "Sorgrass", a perennial hybrid type of Sudan grass, have shown outstanding vigour and leafiness.

In an investigation of the breeding behaviour of star grass (*Cynodon dactylon*) the progenies of the best pasture types have shown considerable variation in habit, in leaf type and in the panicles, suggesting that this type of star grass is a cross pollinating, xenogamous plant and that for the formation of good seed a mixture of clones is required. The progenies of a more robust, forest type of *C. dactylon,* unsuitable for cultivation, were completely uniform and this type, possibly a tetraploid, is apparently either self-pollinating or apomictic.

A highly stoloniferous and leafy, late flowering type of Rhodes grass (*Chloris gayana*) found in the West Suk district of Kenya was outstanding in a preliminary trial and a few selected clones of it are now being developed into a new cultivated variety.

A preliminary grazing trial which lasted four years, and included several varieties of *Setaria sphacelata, S. splendida* and also 11 other species of grass, has now been completed. Of *Setaria sphacelata* the Lugari variety was the best as regards leafiness and persistence, followed by the Gilgil, Nandi and Elgon varieties. Clones of *Setaria splendida* planted in 3 ft. rows and used for grazing were generally inferior to those of *S. sphacelata* when used in ordinary leys, as they did not form sufficient cover and were of a fodder habit rather than a grazing type, though two clones have shown good vigour and persisted throughout the four years of the trial. The other 11 grasses in the same trial included *Phalaris tuberosa, P. daviesi* (a hybrid developed in Australia), another *Phalaris* hybrid from Aberystwyth, "Ronpha" grass which is also a *Phalaris* hybrid, *Bothriochloa intermedia* from U.S.A. and local Kenya grasses as follows: *Bothriochloa glabra, Capillipedium parviflorum, Entolasia imbricata, Eulalia geniculata, Loudetia arundinacea,* and *Pennisetum polystachyon,* a leafy variety from Mombasa. The four types of *Phalaris* did not persist under grazing and disappeared in the first two years, except the Ronpha grass, which lasted longer but produced very little herbage.

Bothriochloa intermedia, Capillipedium parviflorum and *Eulalia geniculata* have shown very good persistence and were dense and vigorous even in the fourth year. *B. intermedia* was, however, unpalatable, and the other two, though palatable, were rather low in protein (6-8 per cent) in their fourth year of growth. The *Entolasia* grass contained 15-16 per cent of crude protein in the last year and was palatable though it formed rather thin stands and some plants died out towards the end of the trial. The *Capillipedium, Entolasia* and *Eulalia* grasses deserve further trial. They were also untouched by the armyworm infestation which attacked the plots in March, 1961.

(3) Fertilizer Experiments

Four experiments have been completed this year, and will be written up for publication in 1962. The results are, however, presented here in summarized form. The first experiment was concerned with the effects of potassium, calcium and magnesium on lucerne. The three other experiments were concerned with the effects of calcium and sulphur on lucerne alone, lucerne with setaria, and Kenya white clover with setaria.

The following results show the effects of potassium, calcium and magnesium on lucerne, in the 1st year, 1959, and show the increases over the phosphate alone treatment which was the control.

Lucerne—Increase over Control in Lb. D.M. per Acre, 1959

Ca	K	Mg	CaK	CaMg	K Mg	CaK Mg	L.S.D. 1%	L.S.D. 0·1%
848**	502*	728**	1,350***	1,065***	1,325***	1,543***	635	875

Control Yield 4,002 lb./acre.

It is apparent from these results that the three elements alone have given increased yields, while the response from K is the only one which failed to reach the level of significance at 1 per cent i.e. at 635, although the response is significant at the 5 per cent level. The combined effect of Ca-K-Mg caused the largest increase in yield from which it appears that all three elements together are required for the optimum production from lucerne.

The results for 1959 and 1960 show a rather similar pattern.

Lucerne—Increase over Control in lb./acre of D.M., 1960

Ca	K	Mg	CaK	CaMg	K Mg	CaK Mg	L.S.D. 1%	L.S.D. 0·1%
1,000***	741**	564	760**	1,535***	1,175***	2,276***	724	997

Control Yield 6,260 lb./acre.

The two main differences between the results for 1959 and 1960 are that the Ca-K response in 1960 is less than in 1959 by a substantial amount, possibly as a result of the lack of Mg. On the other hand the CaK-Mg response for 1960 shows a marked increase over the 1959 response.

LUCERNE—INCREASE OVER CONTROL IN LB./ACRE OF D.M., 1961

Ca	K	Mg	CaK	CaMg	K Mg	CaK Mg	L.S.D. 1%	L.S.D. 0·1%
692	−149	870**	912**	265	1,535***	1,255***	789	1,087

Control Yield 4476 lb./acre.

It is of particular interest that the KMg and CaKMg responses have been maintained although the unusually large increase in yield from the CaKMg treatment in 1960 has not been maintained in 1961. The Ca and K treatment responses have failed to reach the 1 per cent level of significance, as well as the CaMg treatment. The evidence indicates that all three elements are required for the proper growth of lucerne, and it also suggests that the balance between the three nutrients is important in view of the differences between the KMg and CaKMg and CaK responses.

The following three experiments were conducted with the same treatments and the same design, the differences being that the first experiment was carried out on lucerne only, the second on lucerne with setaria and the third on Kenya white clover with setaria. The main treatment comparisons were the effects of calcium alone, sulphur alone and calcium and sulphur together on productivity. Triple superphosphate was included with each treatment at the rate of 300 lb./acre each year. As with the results of the previous experiment, some treatments which are of less interest have been excluded from the tables which follow. The experiments were conducted over the three seasons, 1959, 1960 and 1961. The results for each year are given as the increase over the phosphate alone treatment.

PURE LUCERNE—INCREASE OVER PHOSPHATE TREATMENT AS LB./ACRE OF D.M., 1959

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
−390	200	408**	391	881***	396	545

Control 4,032 lb./acre.
Phosphate 5,027 lb./acre (995***).

PURE LUCERNE—INCREASE OVER PHOSPHATE TREATMENT AS LB./ACRE OF D.M., 1960

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
−90	1,098**	680	163	704	841	1,158

Control 4,568 lb./acre.
Phosphate 6,506 lb./acre (1938***).

PURE LUCERNE—INCREASE OVER PHOSPHATE TREATMENT AS LB./ACRE OF D.M., 1961

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
61	115	−223	689***	653***	402	554

Control 3,088 lb./acre.
Phosphate 5,304 lb./acre (2,216***).

It is apparent from these results that the application of triple superphosphate at the rate of 300 lb. per acre per year will maintain an increased yield of lucerne over no phosphate. The increase in yield in each year is significant at the 0.1 per cent level. Over and above the increase from the application of phosphate it would appear that in the first year a low rate of calcium and sulphur as gypsum and as $CaCO_3$ plus Na_2SO_4 will increase the yields of lucerne by a further 400-900 lb. per acre of dry matter. Although no statistically significant increase in yield resulted from the application of pure sulphur in the first and third years, a substantial increase of 1,000 lb. per acre occurred in the second year which is significant at the 1 per cent level. The lack of significant response in the third year may well have been due to a low supply of calcium as indicated by the response from the high calcium and sulphur treatment as gypsum in the third year, and in view of the results of the first experiment reported, possibly also to inadequate supplies of potassium and magnesium.

The results for the seasons 1959, 1960 and 1961 for the clover-setaria experiment are given below:

CLOVER-SETARIA COMBINED YIELD—INCREASE OVER PHOSPHATE ALONE AS LB./ACRE OF D.M., 1959

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
739	290	885**	379	250	786	1,082

Control 4,180 lb./acre.
Phosphate 6,262 lb./acre (2,082***).

CLOVER-SETARIA COMBINED YIELD—INCREASE OVER PHOSPHATE ALONE AS LB./ACRE OF D.M., 1960

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
302	1,313***	781**	902**	2,211***	668	920

Control 5,348 lb./acre.
Phosphate 8,520 lb./acre (3,172***).

Clover-Setaria Combined Yield—Increase over Phosphate alone as lb./acre of D.M., 1961

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
437	2,202***	3,107***	2,897***	2,666***	921	1,268

Control 4,092 lb./acre.
Phosphate 8,102 lb./acre (4,010***).

The results of the combined clover-setaria yields compared with those of the lucerne, indicate that the clover-setaria mixture is more responsive than the pure lucerne; however, the general trend of the results in the clover-setaria experiment, although more pronounced, is similar to that in the lucerne results. The sulphur response in the clover-setaria results is most marked and would appear to be increasing; similarly with the results of the Ca+S and 2Ca+2S treatments. The highest yield of dry matter was recorded in 1961 from the treatment receiving Ca+2S, a yield of 12,597 lb. per acre, which exceeds the CaS and 2Ca+2S treatments by approximately 1,400 lb. and the phosphate treatment by 4,495 lb. which differences are significant at the 0.1 per cent level.

The results indicate that not only is sulphur required for increased yields of clover and grass, but also calcium.

The results for the three seasons 1959, 1960 and 1961 for the lucerne-setaria experiment are given below for the combined yield of lucerne and setaria.

Lucerne-Setaria Combined Yield—Increase over Phosphate alone as lb./acre of D.M., 1959

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
421	482	405	−166	1,769***	776	1,068

Control 3,907 lb./acre.
Phosphate 5,909 lb./acre (2,002***).

Lucerne-Setaria Combined Yield—Increase over Phosphate alone as lb./acre of D.M., 1960

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
1,137**	370	258	1,095**	1,523***	1,019	1,403

Control 5,788 lb./acre.
Phosphate 6,981 lb./acre (1,193**).

LUCERNE-SETARIA COMBINED YIELD—INCREASE OVER PHOSPHATE ALONE AS LB./ACRE OF D.M., 1961

Ca	S	Ca + S as Gypsum	2Ca + 2S as Gypsum	Ca + S as $CaCO_3$ + Na_2SO_4	L.S.D. 1%	L.S.D. 0·1%
219	−1,043	526	95	2,117***	1,099	1,513

Control 2,177 lb./acre.
Phosphate 4,457 lb./acre (2,280***).

As in the results of the two previous experiments given above it is apparent that calcium and sulphur are both necessary for increased production of lucerne and setaria when compared with the effect of phosphate alone. However, it seems from the 1961 results that calcium and sulphur as gypsum were ineffective in raising the yields but as $CaCO_3$ and Na_2SO_4 they were highly effective. It is suggested, in view of the results of the first experiment with the three bases, K, Ca and Mg, that the rather lower yields from the lucerne-setaria experiment as a whole may be due to low soil levels of potassium and magnesium which were not applied in the experiment, as in many of the treatments the lucerne has died out or the population has been drastically reduced.

The results from the three experiments with Ca and S clearly show that in order to achieve sustained increases in the yields of lucerne or legume-grass mixtures, both elements must be present in adequate amounts. It is also of interest to note that the increased yields from an annual application of triple superphosphate at the rate of 300 lb./acre are substantial, whereas in a number of previous experiments with rates of application of 200 lb./acre or less, no positive responses were recorded after the first or second cut in the first year. It is therefore suggested that the critical level of application for triple superphosphate on legumes or grass-legume mixtures, may be somewhere between 200 and 300 lb. per acre. Below this level it becomes more difficult to obtain responses to the other major elements.

In an " all-1" experiment on Rhodes grass, the mean of the six cuts for the year gave the following yields in cwts. D.M. per acre:

Control	Complete	−N	−P	−S	−K	−Ca	−Mg	NPS
16·19***	30·12	26·99***	17·44***	26·81***	27·84*	28·78	27·99*	26·69***

The complete treatment has given the highest yield, and those marked *** are significantly less at the 0.1 per cent level, while −K and −Mg are significantly less at the 2 per cent level *. It will be observed that where the three bases are excluded, there is again a highly significant drop in yield compared with the complete treatment.

These results are in line with those from a similar exploratory experiment started a year earlier. The trend in that one was for the minus sulphur plots to become the most unproductive of all in the second year, after showing a slight decrease in the first year.

(4) Evaluaton of Pastures by Animal Production

(*a*) *The assessment of milk production by means of twin cattle*

This experiment, which was described in the Annual Report for 1960, was continued in 1961, on the same pasture, e.g. a *Setaria* ley planted in 1957. In 1960 no fertilizers had been used and the carrying capacity of the pasture was low. In 1961 top-dressing of part of the pasture was carried out between April and July, using 2 cwt. of triple superphosphate and 4 cwt. of sulphate of ammonia, the latter being applied after the disappearance of the armyworm, which had temporarily denuded the pasture. The effects of the fertilizers were then studied at two different stocking rates and the results were compared with those of the control paddocks which received no fertilizers.

The yields of milk from the pasture so far are as follows:

(i) from the paddocks which had received fertilizers:
at the heavier stocking rate—500 gals. per acre
at the lighter stocking rate—369 „ „ „

(ii) from the control paddocks:
at the heavier stocking rate—223 „ „ „
at the lighter stocking rate—166 „ „ „

The yield of milk from the paddocks which had received fertilizers, over and above the yield obtained from the control paddocks, was sufficient to pay for the cost of the fertilizers and to leave a credit balance of Sh. 103 per acre at the heavier stocking rate. The cows in this experiment remained in the paddocks day and night, except for milking, dipping and weighing, and they all remained there until September when numbers were reduced to compensate for the reduced growth rate of the grass. No hay was fed and concentrates were not fed to the animals concerned.

(*b*) *A comparison of liveweight gains from Nandi Setaria, Nzoia Rhodes and molasses grass*

In this, the fourth year, liveweight production again declined. The results are tabulated below:

Species	1959	1960	1961
	lb.	*lb.*	*lb.*
Rhodes	327	195	143
Setaria	297	170	79
Molasses	327	116	36

The decline in production of all the species in 1961 was partly the result of the delay to the start of grazing common to all the experiments. No fertilizers were applied in 1961, but all the paddocks had been used for night-paddocking 130 head of stock for three months in the dry season, and the dung was subsequently spread by chain harrowing.

(c) *Natural Grassland Rotation Trial*

The results of this, the fifth year, are again similar to those of previous years. The two leading treatments have been the four paddock rotation and continuous grazing, and the three paddock deferred rotation has given the lowest liveweight gain.

F 1 Red Poll x Boran steers and heifers were again used, as in 1960. The results are given below:

Liveweight gain per acre (lb.)

Four paddock rotation	164·0
Three paddock, deferred rotation ..	127·5
Continuous grazing	159·5

The differences are non-significant.

(5) Seed Production

The production of pasture seed continued to rise, but the newly planted areas in particular were heavily damaged by the armyworm and several acres had to be replanted. The harvests were then seriously affected by the unusually wet weather during October to December and much seed was spoilt, partly through lack of sunshine during the pollinating period. It is hoped that there will be some clover seed harvested, following renewed insect activity during periods of sunnier days.

Forty-one acres of "Mother" seed, nine acres of legumes and thirty-two acres of grasses, including an improved selection of setaria and an increased area of Congo signal grass, were planted.

4,500 lb. of seed have been produced so far of which 3,000 lb. will be offered for the Seed Certification Scheme and commercial use, while the balance will be retained for departmental and internal use. Both the quantity and quality of the harvest have been impaired by adverse weather conditions.

(6) Pasture Research Chemist's Investigations

The chemical changes that have been found to occur in legumes, cereals and grasses as they grow to maturity have been discussed in previous years almost entirely from the standpoint of animal nutrition. It is, therefore, the intention this year to give more details of plant composition as it occurs either at a specified stage of growth or at different stages of growth.

Legumes

(*a*) "Provence" lucerne grown at an altitude of 8,300 ft. and sampled on each occasion that it reached the early flowering stage of growth had the following composition:

	Per cent of Dry Matter			
	Leaf	S.E.	Stem	S.E.
Ash	10·67	0·26	11·05	1·06
Crude protein	34·93	0·79	22·09	1·45
Ether extract	3·95	0·23	1·86	0·23
Crude fibre	13·06	0·45	31·40	1·33
N-free extract	37·39	1·26	33·60	1·69
Ca	1·06	0·07	0·62	0·04
P	0·38	0·02	0·36	0·02
Proportion of 100 g. dry matter	53·8	1·09	46·2	1·09

These results are the mean values of eight harvests obtained within a 12-month period; eight harvests were possible because during all periods of relative dryness the lucerne was irrigated from an adjacent tank containing a urine/water mixture collected from the nearby dairy. Fertilizer phosphorus was applied once during the short rains and once during the long rains to give approximately 33 lb. citric-soluble P_2O_5 per acre on each occasion. Fertilizer potassium was applied on five occasions to give 180 lb. K_2O per acre per application.

It is seen that the ratio of leaf to stem is about 54:46 and that the crude protein is much higher and the crude fibre much lower in the leaf than in the stem. Phosphorus is at very much the same level in leaf and stem but calcium is appreciably less in the latter.

(b) In order to study the changes in the chemical composition of lucerne throughout its growth the legume was planted in seed beds which received no fertilizers (O); 200lb. triple superphosphate per acre (P); 200 lb. potassium sulphate per acre (K); 200 lb. gypsum per acre (G); P with K at the same rates as above and P with G at the same rates as above. The plants grew somewhat erratically under conditions of unfavourable rainfall and approximately three months after planting they were cut back almost to ground level to begin a new growth cycle, from which samples at different growth stages were obtained at weekly intervals for nine weeks.

Plant analysis showed that the effects of the six different treatments on the composition of the dry matter were dominated by the effects of maturation. The mean effects of the treatments during the nine weeks growth were as follows:

Per cent of Dry Matter	Treatment						S.E.
	(O)	(P)	(K)	(G)	(P+K)	(P+G)	
Silica-free ash	10·24	10·32	10·52	10·16	10·26	10·45	0·19
Ca	1·10	0·99	1·02	0·98	1·12	1·07	0·03
P	0·30	0·33	0·34	0·31	0·32	0·34	0·005
S	0·25	0·27	0·27	0·26	0·24	0·25	0·004
N	3·72	4·22	4·00	4·07	3·95	3·97	0·10
CHO*	62·35	59·34	60·40	60·36	61·02	61·05	0·68

*CHO = 100 − (Crude protein + Ether extract + Ash)

The mean effects of maturation on composition over the same period were as follows:

Week	Per cent of Dry Matter					
	Silica-free Ash	Ca	P	S	N	CHO
1	11·13	1·11	0·46	0·30	5·00	52·44
2	11·07	1·02	0·40	0·28	4·73	54·73
3	10·73	1·03	0·35	0·29	4·26	58·46
4	10·61	1·04	0·31	0·26	4·00	60·62
5	10·31	1·08	0·30	0·25	3·64	63·36
6	9·52	1·24	0·28	0·25	3·76	63·35
7	9·96	1·10	0·29	0·24	3·93	61·82
8	10·15	0·99	0·27	0·23	3·41	64·71
9	9·43	0·93	0·24	0·21	3·17	67·29
S.E.	0·23	0·04	0·006	0·005	0·12	0·85

The percentage content of silica-free ash, N, P and S respectively decreases as the plants grow to maturity and the percentage content of CHO increases. Calculations show that there is a very highly significant relationship ($P>0.1$ per cent) between each of these variables and log. t or t, where t represents time, in weeks. Calculations also show that N and P; N and S and P and S are directly and very highly significantly related to each other and that N, P and S are inversely and very highly significantly related to CHO.

(*c*) A further experiment on lucerne grown without fertilizers showed that its crude fibre content is also directly related to the stage of maturation and the following equation expresses the relationship:

Crude fibre $= 14.60 + 16.68$ log. t, where t = time in weeks ($n = 9$; $r^2 = 0.87$).

In this experiment the true protein-N as well as the crude protein-N was studied and it was found that the former fraction is also directly and very highly significantly related to the stage of maturation of lucerne. The rate of decrease of the true protein-N with log. t differed from that of the crude protein-N at nearly the 1 per cent level of significance, a circumstance which can be accounted for by the very slight though significant increase in the ratio of true to crude protein-N as the lucerne grew to maturity, thus:

$$TP/CP\text{-}N = 0.73 + 0.112 \text{ log. t, where t = time in weeks.}$$

Cereals

The decrease of true protein-N and crude protein-N and of N, P, S and silica-free ash, and the increase of CHO and crude fibre with time; the N and P, N and S and P and S interrelationships and the N, P, S and CHO interrelationships which were found in the dry matter of lucerne have also been shown to occur in wheat and barley as these cereals grow from the seedling to the grain harvesting stage.

Both cereals had been planted on the same day and sampling began 16 days after planting. Samples were obtained at weekly intervals until the grain was harvested 17 weeks later, the whole plants being taken for analysis. Each of the cereals reached the piping stage during the eighth week of sampling and from the ninth week onwards the ears were sampled in addition to the whole plants. The ears were sampled twice weekly in order that any chemical changes might be

traced more easily. In the event this precaution was hardly necessary for in wheat heads CHO; true protein-N; crude protein-N; P and S and gross energy remained remarkably constant from ear-emergence to maturity while the crude fibre decreased progressively and highly significantly (P>0.1 per cent) during the same period and the ratio of nitrogen-free extract to CHO increased progressively and very highly significantly. In the barley ears CHO; the ratio nitrogen-free extract to CHO and gross energy remained remarkably constant but there was a slight though highly significant gain in true protein-N, crude protein-N, P and S with time, over the same period and a concomitant gain in the ratio of true to crude protein-N. These changes are tabulated below:

THE COMPOSITION OF WHEAT AND BARLEY EARS AND GRAIN—PER CENT OF DRY MATTER

	Wheat		Barley	
	Ears	Grain	Ears	Grain
Ash .. .. =	5·69 ± 0·30	2·26	5·26 ± 0·30	3·29
Crude protein-N =	2·07 ± 0·04	2·39	1·87 + 0·0085 t	2·64
True protein-N =	1·68 ± 0·04	2·16	1·415 + 0·016 t	2·39
Ratio: TP/CP =	0·81 ± 0·02	0·90	0·77 + 0·004 t	0·90
Gross energy (kg-cal/g) .. =	4·34 ± 0·04	4·36	4·33 ± 0·03	4·53
P .. .. =	0·323 ± 0·007	0·448	0·217 + 0·00144 t	0·301
S .. .. =	0·165 ± 0·003	0·181	0·147 + 0·0006 t	0·190
Crude fibre .. =	28·65 − 0·355 t	3·05		2·73
CHO .. .. =	79·38 ± 0·34	80·5	79·41 ± 0·42	78·11
Ratio: Nitrogen-free extract/CHO =	0·64 + 0·0046 t	0·96	0·87 ± 0·007	0·97

n = 16 throughout; t = time in days.

There is of course an increase in the percentage of dry matter contained in wheat and barley as each grows to maturity and there is also an increase in the percentage of dry matter contained in their ears between emergence and the time of harvesting the grain. Two forms of regression were used to examine the drying-out process, namely per cent of dry matter on log. t and log. per cent of dry matter on log. t. The latter expression, though it no doubt could also be improved, gave the better fit and it was found that the difference between the respective rate of increase of dry matter content of the whole wheat and barley plants was non-significant. This same result held also for the respective ears.

It is perhaps worth noting that the chemical composition of wheat ears on emergence appears to offer an indication of the composition of the grain that is to be harvested some eight weeks later.

Grasses

(*a*) Relationships such as those described for legumes and cereals have also been well established as occurring in grasses such as *Hyparrhenia dissoluta,* star grass, etc., as they grow to maturity. It was suggested in an earlier Annual Report (1959) that all the combined effects concerned can most easily be demonstrated by the changing ratios of one to the other. Thus if the ratio CHO/N is plotted

over a range of N values, CHO/P is plotted over a range of P values and CHO/S is plotted over a range of S values, the respective graphical representations conform to a simple curvilinear pattern between which there is probably no significant difference.

The changing ratios of CHO/N and CHO/P in relation to N and P respectively, have been studied in fertilized and non-fertilized star grass pasture at Muguga during the years 1953-1956, 1956-1960 and 1958-196-. Over this last named and as yet unfinished period the changing ratios of CHO/S in relation to S are being studied in addition to the other two.

In the 1953-1956 experiment the fertilized pasture received $1\frac{1}{2}$ cwt. triple superphosphate and $1\frac{1}{2}$ cwt. sulphate of ammonia for establishment and annually thereafter; in the 1956-1960 experiment the fertilized pasture received 150 lb. triple superphosphate and 50 lb. urea per acre for establishment in 1956 and 50 lb. urea per acre following each of the seven harvests that followed; in the 1958-196- experiment the "control" sward was that established in 1958 without fertilizer, but it did receive 200 lb. sulphate of ammonia per acre in 1959 and in 1960. The fertilized swards were those which had respectively received $2\frac{1}{2}$ cwt. and 16 cwt. triple superphosphate per acre for establishment in 1958 and two dressings of sulphate of ammonia at the same time and at the same rate as the "control".

Over a period of some eight years it has been found that changes in the ratio of CHO/N and CHO/P in relation to N and P, and over a period of some four years changes in the ratio of CHO/S in relation to S, all follow the same pattern over the same rainfall distribution pattern whether the star grass was fertilized or not. The fertilizers may significantly affect dry matter production but they do not alter the pattern of change in dry matter production which does not differ significantly from that of CHO/N, CHO/P or CHO/S, nor do they significantly affect the mean ratios of these latter with the single exception of the CHO/P ratio of the grass to which 16 cwt. triple superphosphate was given for establishment. The CHO/P of this latter is very highly significantly lower than that of the control but it does not differ significantly from the mean CHO/P ratio obtained from the grass that received $2\frac{1}{2}$ cwt. triple superphosphate per acre for establishment.

(*b*) Attention has been given to the true protein (TP) as well as the crude protein (CP) contained in legumes, cereals and grasses from their early growth to maturity and it has been seen that the ratio TP/CP may remain fairly constant throughout, as with wheat (0.83 ± 0.014), barley (0.81 ± 0.015), star grass (0.77 ± 0.003), *Hyparrhenia dissoluta* (0.80 ± 0.02), and *Brachiaria ruziziensis* (0.68 ± 0.01) or it may increase very slightly, though significantly, as with lucerne and *Setaria sphacelata* whose TP/CP ratio increases in the following way:

$$TP/CP = 0.67 + 0.0084\,t, \text{ where } t = \text{time in weeks.}$$

The difference between the crude and true protein is a measure of the non-protein nitrogen contained in a plant and as seen from the foregoing it can amount to some 30 per cent of the total nitrogen held by the plant. Further experiments have shown that this amount can be exceeded. The circumstances were as follows: in 1956 an experiment using star grass was planted on a field scale using amongst others, the following treatments:—

(A)—50 lb. urea per acre for establishment and the same amount applied following each of the ten subsequent grazings.

(E)—50 lb. urea per acre and 150 lb. triple superphosphate per acre for establishment and the urea subsequently applied as with (A).

(F)—18 lb. triple superphosphate, as a starter dose for establishment.

It became apparent that (A) treatment significantly increased the nitrogen content of the grass and so between the 10th and 11th grazing the herbage from each treatment was examined at weekly intervals for nine successive weeks. The grass by this time was in its fourth year. The mean values for the crude protein-N over these nine weeks were (A)—3.212 per cent; (E)—2.698 per cent and (F)—1.962 per cent. (A) was significantly higher than (E) and very highly significantly higher than (F), and (E) was very highly significantly higher than (F). The mean values for true protein-N were (A)—1.764; (E)—1.678 and (F)—1.548. The differences between these values were non-significant. The ratios TP/CP were (A)—0.55 $\pm$ 0.024; (E)—0.63 $\pm$ 0.026 and (F)—0.79 $\pm$ 0.011. (A) was significantly lower than (E) and very highly significantly lower than (F) while (E) was very highly significantly lower than (F). It will be noted that the TP/CP ratio for (F) does not differ significantly from the value of 0.77 $\pm$ 0.003 reported above for star grass which was in its second year and growing without fertilizers. It will also be noted that the urea-treated grass contained about 45 per cent of its nitrogen in non-protein form as against about 20 per cent in the grass which had received only a starter dressing of phosphate almost four years earlier.

The Grassland Research Station, Molo

The lack of rain followed by excess, was a preoccupation during the year. The early rains were below average and badly distributed, and were followed by almost continuous rain from August until the end of the year. Rainfall during the first nine months was about half the average but during the last quarter over half the year's rain was recorded, bringing the total well above average. Nevertheless, this district suffered less than many other parts of the country.

Positive evidence of effective nitrogen fixation in mixed swards was obtained for the first time. Such evidence was found only in older swards in which clover was dominant in the establishment year.

Factors affecting the regeneration of subterranean clover received attention and promising results have emerged. The need for an annual pre-rains application of superphosphate has been clearly demonstrated on a clover-dominated mixture.

Yield in Lb. D.M. per Acre from One Cut

	Clover	Grass	Total
Control	263	52	315
200 lb./acre superphosphate..	1,241	408	1,649
L.S.D., P = 5%	156	42	201

It is of interest to note that phosphate has increased the grass production to a greater extent than the clover production. Previous results indicate that this is unlikely to be due to the direct effect of the phosphate, so the logical inference is that there has been effective nitrogen fixation.

Regeneration in association with a greater proportion of grass remains a problem. In a factorial trial where subterranean clover was sown at 5 lb. per acre, with 5, 15 and 25 lb. per acre of Cocksfoot, in 1960 regeneration was negligible despite the presence of 30 per cent of clover in the establishment year. There were no differences in the production of grass or clover in either year with different grass seed rates. Seed production and seedling establishment showed no differences due to treatment. Pre-rains surface cultivation significantly increased seedling establishment and clover production but the amount of clover, of the order of 1 to 5 per cent, was too small to contribute to the sward. There was no response to phosphate, which is attributed to insufficient clover.

The effect of increasing the clover seed rate is being investigated in a trial established during the year. Clover was sown at 4, 8 and 12 lb. per acre with 10 lb. per acre of Cocksfoot. The first cut showed a significant increase in the dry matter production of clover and the total production but grass production was unchanged. In the second cut, however, the clover and total production was significantly increased with a significant decrease in grass production with increasing clover competition. Clover percentages were 17, 34 and 45 respectively. It remains to be seen whether there is sufficient clover for adequate regeneration with this amount of grass.

Nitrogen responses on grass confirm the need for nitrogen, in some form, to maintain a satisfactory level of ley production.

Main Effects of Nitrogen on Second Year Perennial Ryegrass

Yield in lb. D.M. per acre

Control	80 lb.N/acre	160 lb.N/acre
4018	7,454	9,704
L.S.D., P = 0·1%	387 lb.	

Phosphate produced no significant effect but there was a small and significant N x P interaction. The level of response at 39 lb. dry matter per lb. of N compares very favourably with responses obtained in the U.K.

Interesting magnesium, and magnesium x phosphate interactions were recorded on Louisiana white clover but, although statistically significant, are too small to be of practical importance at present. Magnesium responses were recorded on subterranean clover observation plots where late season growth was improved.

Differences in the persistence and productivity of various ley grasses indicate the potential of the more promising species. Nandi Setaria which produced no worthwhile growth in the establishment year has outyielded all other grasses in the second and third years. Other slow establishing grasses namely S.170 Tall Fescue, S.37 Cocksfoot and to a lesser extent commercial *Phalaris tuberosa* have shown desirable qualities of production and persistence. The Ryegrasses, S.24 and H.1, which gave outstanding yields in the establishment year are now unproductive despite a moderate annual nitrogen top-dressing. Kikuyu grass has amply demonstrated its lack of potential on poor soils. As the ideal companion grass for subterranean clover should not compete too strongly in the establishment year, some of the above mentioned grasses seem promising.

Grassland Research Work at Katumani and Marigat

The integration in October of the dry-areas pasture research centres at Katumani and Marigat allows the work of both centres to be reported here together.

Work has continued on the management and improvement of natural grasslands, including the control of bush; on leys and annual silage crops for marginal farming areas; and (at Marigat) on irrigated pastures. All have been affected by the unusual pattern and quantity of rainfall which fell during 1961.

RAINFALL

(*Inches*)

	MARIGAT (Baringo) 3,400′		BARAGOI (Samburu) 4,500′		CHEMOGOCH (Baringo) 5,200′	
	18-year Average	1961	21-year Average	1961	14-year* Average	1961
January ..	0·97	0·17	0·51	1·41	0·54	—
February ..	0·73	0·28	1·28	0·73	0·94	0·10
March ..	1·52	2·29	2·40	1·21	2·82	1·78
April ..	3·82	1·17	4·34	3·08	5·12	2·43
May ..	3·05	1·31	2·23	2·74	4·63	4·51
June ..	2·53	1·39	0·69	2·84	3·60	2·22
July ..	5·11	4·70	0·91	1·80	6·49	4·22
August ..	4·04	3·67	1·06	6·38	4·60	6·94
September..	1·31	0·81	0·28	0·19	3·03	3·18
October ..	0·92	3·30	2·13	7·24	1·97	5·77
November..	0·85	11·24	2·66	11·37	1·56	13·36
December..	0·69	7·33	1·34	2·63	2·15	6·45
TOTALS ..	25·54	37·66	19·93	41·62	37·45	50·96

*Average for Emining (7 miles north).

Rainfall records for Katumani (and the Kampi-ya-Mawe substation) are given in the report of the Agricultural Research Officer, Southern Province.

(*a*) NATURAL GRASSLAND

Work within Grazing Schemes.—Studies on vegetation changes within controlled grazing schemes have been further widened and some existing transects re-recorded.

Data from the Seya-Ngarone scheme (formerly Seya Barsalinga) in Samburu have shown no significant deterioration to have occurred in three of the blocks over the 28 months up to May, 1961, despite generally poor rainfall; whilst the fate of the fourth block—which during this period received more than its normal share of grazing—is clearly shown, with a 59 per cent decrease in the population of *Cynodon*, and a complementary increase in bare ground.

The same technique, first applied to the El Bata scheme in May, showed there are three distinct grassland types:—

SPECIFIC FREQUENCY OF KEY SPECIES, EL BATA, MAY 1961

Grassland Type	A	B	C
Enneapogon brachystachyus	59	7	—
Chrysopogon aucheri	T	3	25
Microchloa kunthii	—	—	26
Chaetostichium spp.	18	3	—
Latipes senegalensis	6	15	T
Cynodon dactylon	—	T	11
Digitaria macroblephara	—	—	11
Chloris myriostachya	T	1	6
*Other species**	53	96	71

* Mainly *Eragrostis aulacosperma, Tragus berteronianus, Sporobolus pellucidus, Enneapogon cenchroides, Sporobolus spp.* (perennial), *Tetrapogon spathaceus, Aristida spp.* and *Cypholepis yemenica.*

Re-seeding of Denuded Land.—All experiments have been discontinued, and the results are now being prepared for publication. In general, recent results have confirmed those previously reported.

One new trial at Salaban, near Marigat—on a denuded wind-blown, alluvial soil—showed most markedly the superiority under these conditions of a deep-ploughed, rough seedbed to one cultivated and/or finely worked. Work elsewhere, where a rigid-tine cultivator has been found to be suitable, confirmed cultivation prior to seeding as normally preferable to cultivation after seeding.

Bush Control.—The preliminary burning experiment at Katumani has been concluded; and at Cheplesil, Baringo, the prescribed course of the Holt IXa Bush Clearing Experiment was completed in September. The results from both will be published.

The poor long rains in Machakos and Kitui made it impossible to apply the scheduled October burn to the Yatta Burning Experiment or to the Katumani experiment on bush control with fire and goats. In Baringo, the Fire/Goat/Lopping Experiment was burnt in February. For the first time, the thermocolour method was used to determine fire temperatures. The fire was only moderate and largely confined to grass level, but temperatures in excess of 1,000° F. were obtained locally. It was found that a temperature of 400° F. was sufficient to kill the top growth of regenerating *Tarchonanthus* (Leleshwa), and cause the bush to recommence growth from ground level.

At Chemogoch, an experiment with the Holt IXa Bush Breaker on the effect of time of clearing has confirmed that an increase in seedling population follows the use of this machine, irrespective of season of application. Good seedling control was effected by a subsequent fire where this was applied within one year of clearing. The greatest threat lies in *Acacia brevispica*, and increases of as much as 350 per cent were obtained during the 20 months following clearing. A wealth of detail has been accumulated from this trial, and is at present being analysed.

A trial at Katumani on the effect of Monurid (CMU) on *Acacia brevispica*, where the chemical was applied in spray form around the base of individual bushes, has shown ½ and 1 gm. per bush to be ineffective. Of ten bushes treated with 2 gms., and recorded 21 months later, four were found to have been killed, five partially affected, and one was unaffected. 4 gms. and 8 gms. per bush gave no better kill, but the damage to bushes still living was greater, and some more may yet die. Also, at the higher concentrations, the chemical was unselective, whereas with 2 gms., all the dead trees were small, with less than 12 stems and an average height of less than 5 ft.

At Baragoi (Samburu), methods of *Disperma* control are under comparison; records taken in August, one year after application, gave the following result:—

PERCENTAGE GROUND COVER

(*Mean of* 3 *sites*)

Method	Alive Disperma	Dead Disperma	Other Herbs	Perennial Grass	Annual Grass	Bare Ground	Total
Hand jembe ..	8·2	3·4	9·5	15·5	15·1	49·8	101·5
Gyramor ..	22·0	2·6	7·8	9·5	12·6	48·3	102·8
Holt VIIIb ..	21·1	5·2	8·1	8·5	8·7	51·5	103·1
Cultivator ..	23·6	4·9	7·5	8·4	6·7	54·3	105·4
Control ..	25·7	3·7	6·7	6·8	4·6	57·3	104·8

It should be noted that whereas on the control plots, the *Disperma* was stemmy and about 1¾ ft. tall, following gyramoring it was short and succulent, and of higher browse value.

Grazing Studies.—The seasonal grazing and overgrazing/resting experiments on red and black soils in Machakos have been re-recorded. Little change in grass composition has occurred on the red sand loams, but on the black clays changes have been marked, particularly under the overgrazing treatment. Subsequent records will show whether these changes represent positive trends.

(*b*) DRY-LAND LEYS

Species evaluation.—Unusually heavy rainfall detracted from the value of the observational plots at Katumani and Chemogoch, as all material included grew exceptionally well. Estimated yields of up to 40 tons of green material per acre were obtained at Chemogoch; and at Katumani, a new-sown ley of Mpwapwa Rhodes grass (*Chloris gayana*) yielded 23 tons of green material per acre (@ 16 per cent D.M.) when cut ten weeks after sowing. Such yields are completely outside the normal range.

Some damage was experienced at Katumani through shoot fly (unidentified) and *Cercospora*, to both of which *Cenchrus* was particularly susceptible. In Rhodes grass, the shoot fly killed many Masaba seedlings, whilst Mpwapwa was virtually unaffected.

Establishment Studies.—A series of experiments at Katumani on *Cenchrus* has shown weed competition to be the most potent factor affecting establishment. It is necessary to relate the seed rate to the expected weed threat, and only on clean land, or with row planting and inter-row weeding, can the seed rate be reduced with safety to below 3 lb. P.G.S. Supplementary harrowing and/or consolidation applied after sowing had little effect. Rhodes grass, and the Mpwapwa variety in particular, is the only ley grass tried which is able to compete with a heavy weed infestation.

Ley Management.—The value of fertilizers on *Cenchrus* and *Chloris* leys at Katumani remains unproven. In one experiment on Rhodes grass, where six yield cuts were taken over three years, a significant response was obtained only on one occasion.

Panicum maximum (Mackinnon Road), planted at 8 ft. x 1½ ft. and managed primarily for dry-season utilization, has yielded in three cuts during 1961 a total of 1.8 tons of dry matter per acre. The application of up to 300 lb. per acre of sulphate of ammonia had no significant effect on yield, whilst intercropping reduced grass yield to 1.0 ton of dry matter. At the end of the dry season, the crude protein content of this grass was unusually high, at 11 per cent of the dry matter. This experiment is sited at Katumani.

An investigation on row spacing in *Cenchrus* indicates the superiority of wide rows, even at a time when soil moisture is abundant. The figures below relate to established leys, cut one month after the commencement of the October rains:

YIELD OF CENCHRUS CILIARIS (LB. D.M. PER ACRE)

(*Mean of two varieties*)

Broadcast	748
1ft. rows	875
2ft. rows	991
3ft. rows	1,044

This result is contrary to accumulated experience with annual crops, as illustrated in the following section.

(*c*) ANNUAL SILAGE CROPS

Species evaluation.—In January, a series of species comparisons was completed, having then covered five seasons. At the January harvest, local white maize and velvet sorghum gave at Katumani significantly higher dry matter yields than sunflower, millet (*Pennisetum typhoides*) or Sudan grass, although in terms of yield of crude protein sunflower and millet were comparable to velvet sorghum, with maize and Sudan grass significantly lower. At Kampi-ya-Mawe (35 miles from Katumani, at 3,700 ft.), velvet sorghum significantly outyielded all other species, and only millet compared with it in terms of crude protein yield. Further results on the inclusion of legumes with maize grown for silage have once more shown no consequent increase in dry matter yield or yield of crude protein per acre. The accumulated results of this work are at present being prepared for publication.

Spacing Studies.—From three experiments harvested during 1961, no significant differences were obtained between the dry matter yields of maize and millet grown at different spacings. The results obtained from the millet crop are given below:

YIELD OF MILLET (LB./ACRE), JUNE, 1961

	SPACING				
	1′ x 6″	1′ x 12″	1′ x 18″	1′ x 24″	1′ x 30″
Green yield	4,351	4,578	4,767	5,297	6,583
% D.M...	34·2	28·2	30·5	23·8	21·5
D.M. yield	1,488	1,291	1,454	1,261	1,415

S.E. = 110. L.S.D. (5%) = 318.

This phenomenon is of particular interest in view of the results reported above for perennial grasses.

(*d*) IRRIGATED PASTURES

Ley Grasses.—The preliminary grazing trial on irrigated grass/legume mixtures at Marigat entered its second year in June. The nine grasses included were estimated to have produced the following yields of dry matter during their first year:

ANNUAL DRY MATTER YIELD FROM IRRIGATED GRASSES

(*Tons per acre*)

(First year)	
Chloris gayana (*Chepararia*)	24·9
Panicum maximum var. trichoglume	24·2
P. coloratum	23·7
Chloris gayana (*Mpwapwa*)	22·3
Cynodon dactylon	21·5
Melinis minutiflora	19·6
Setaria splendida	15·1
Panicum coloratum var. makarikariensis	12·6
Cenchrus ciliaris	11·9

As no fertilizer had been applied at establishment, or during the first year, the replication was sacrificed in order to apply fertilizers in July:

Block I: N, P, K, S, Mg

Block II: P, K, S, Mg

Block III: N

N = 4 cwt/acre sulphate of ammonia.

P = 2 cwt/acre hyperphosphate.

K = 2 cwt/acre muriate of potash.

S = 40 lb./acre gypsum.

Mg = 8 lb./acre magnesium sulphate.

Yield estimates at the second grazing following application yielded the following results:

RELATIVE YIELD OF DRY MATTER
(*All grasses*)

Block I (N, P, K, S, Mg)	Block II (P, K, S, Mg)	Block III (N)
142	100	130
At 9·4% Crude Protein	At 8·8% Crude Protein	At 9·3% Crude Protein

During November and December, the experiment was waterlogged for several weeks. It is hoped, nevertheless, that yields in excess of 30 tons of dry matter can be achieved during the second year of the experiment.

Fodder Grasses.—The comparison of five varieties of Napier grass (*Pennisetum purpureum*) has shown this species to be similar in potential to the best of the ley grasses:

ANNUAL YIELD OF NAPIER GRASS IN TONS OF GREEN MATERIAL PER ACRE*

Minna	137·2 at 16·7% D.M.	(5½ cuts)
Cameroons ..	137·0 at 16·6% D.M.	(6 cuts)
French Cameroons	129·5 at 22·9% D.M.	(7½ cuts)
Uganda Hairless ..	116·1 at 14·5% D.M.	(6½ cuts)
Gold Coast ..	114·6 at 23·7% D.M.	(7 cuts)

*Dry Matter determinations available for two cuts only.

From the information so far available, no varieties of *Panicum maximum* can compare with Napier grass.

Publications

A. V. Bogdan. The depth of planting of Rhodes grass seed. *E. Afr. agric. For. J. 26,* 187.

A. V. Bogdan. Breeding behaviour of *Cenchrus ciliaris* in Kenya. *E. Afr. agric. For. J. 26,* 241.

A. V. Bogdan. Intra-variety variation in Rhodes grass (*Chloris gayana* Kunth) in Kenya. *J. Brit. Grassl. Soc. 16,* 238-239.

A. V. Bogdan. Forage and Pastures, Kenya. Proceedings of the First Crop (Seed) Improvement Seminar for Africa, Nairobi, June 5-21, 1961. pp. 80-83.

A. V. Bogdan and D. J. Pratt. Common Acacias of Kenya. Government Printer, Colony and Protectorate of Kenya. pp. 1-15.

H. W. Dougall (with J. Glover and J. S. G. McCulloch). Protein digestibility in the Ruminant. *Rhod. agric. J.* (1961), 58, 136.

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H. W. Dougall. Effects of terramycin on the composition of sheep faeces. *E. Afr. agric For. J.* (in Press).

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ANNUAL REPORT OF THE SENIOR HORTICULTURAL OFFICER

Review of the Year

It has now been agreed that the Horticultural Products Committee and the Canning Crops Board will be merged into a single statutory body, to be known as the Horticultural Development Council. An interim Council is to be formed until the necessary legislation can be introduced.

The weather during the year was, to say the least, abnormal, a very severe drought being followed towards the end of the year by excessively heavy rain. The horticultural industry escaped with comparatively little damage, partly due to an increase in irrigation facilities, but the pineapple crop was delayed, the plum crop reduced and the best banana plantation in Kenya washed into the sea near Malindi. Some crops, particularly vegetables, are likely to be seriously affected during the first part of 1962.

Pineapples

A survey of the pineapple acreages in Central Province has shown that the publicity and extension work in the African areas, designed to increase production, is taking effect. New plantings are taking place on a substantial scale and these are likely to continue. The annual European plantings remain steady, but the combined acreages should raise the level of production of pineapples in 1962 to more than the 16,000 tons which are required by the canneries for economic running. The intake of fruit during 1961 was 11,635 tons, compared with 11,236 tons in 1960.

The survey has also shown that the fertilizer recommendations, consisting of dressings of sulphate of ammonia, are now in common use in the European areas. In the African areas, however, with the exception of the plantations directly supervised by officers of the Department, little fertilizer is being applied and the standard planting distances are not being employed. This has the effect of reducing by half potential yields from those areas.

Demonstration plots on growers' farms, field days, radio broadcasts and the publication of a *Pineapple Quarterly Newsletter* in the vernacular are among the extension methods being used to improve cultural practices in the African areas.

New experiments in 1961 include an irrigation trial to discover the optimum supplementary irrigation requirements of pineapples, and the interrelation between water supply, plant spacing and fertilizer applications. Four soil fumigation trials were laid down on replant pineapple land to determine the effect of fumigation on plant growth and yield. Finally, work has been started to assess more accurately the altitude limit above which pineapples should not be grown for the canneries. Monthly samples are being collected from the altitude 5,600-6,200 ft. inclusive at 100 ft. intervals for canning and quality tests.

Mealy Bug

Although mealy bug is a widespread and almost universal pest in pineapple plantations, sufficiently heavy infestations to enable accurate assessment of control measures have not been forthcoming in trials laid down for this purpose. There is no doubt, however, that dipping of plant material in malathion before planting, and pre-planting soil treatment with Dieldrin to control the attendant ant, are having a significant effect in reducing mealy bug infestations and are improving yield. Cultural improvements, in particular increased use of sulphate of ammonia,

are also playing an important part by keeping the crop growing vigorously and enabling the plants to stand up to infestation with little adverse effect. Wholesale infestation of young plants which quite frequently destroyed whole crops, particularly when dry conditions followed soon after planting, was a common hazard of pineapple growing a few years ago. This type of infestation is now a thing of the past, provided of course that the recommended control measures have been taken.

Eelworm in Pineapples

In a recent nematode survey of replant pineapple acreages, carried out by Dr. P. Hollis, a Fulbright Scholar, a high percentage of soil samples yielded plant parasites of which the most common was root-knot eelworm. Preliminary findings point to the fact that eelworm populations are reduced significantly by a bare fallow during hot dry weather, and growers should therefore keep their fields clean cultivated for as many months as possible between pineapple crops.

Where soil fumigants such as DD, Ethylenedibromide or Nemagon are used to control nematodes the soil moisture is all important in obtaining satisfactory results—the optimum conditions being about 50 per cent field capacity. Furthermore, under the variable and unpredictable weather conditions experienced in Kenya, DD or Ethylenedibromide with a higher vapour pressure and speed of dispersion is more likely to be effective than Nemagon which has a low vapour pressure and requires up to a six-week period under optimum soil moisture conditions for dispersal to obtain a kill.

Record of Investigations

Fertilizer on Replant Land

This trial has now completed its first ratoon crop and is concluded. The period from planting to the final harvest of the first ratoon crop was 46 months. Details of the trial and yield results of the plant crop were published in Volume II of the Annual Report, 1960. The total crop yields of the plant and first ratoon crops are given in Table 1.

Table 1—Yield in Each Grade—Tons/Acre

Treatment	Grade I	Grade II	Grade III	Total Yield Tons/Acre	Canning Price Value/Acre
					£
A Control Nil	3·3	18·5	2·4	24·2	175
B 420 lb. N	21·4	11·6	1·9	34·9	296
C 525 lb. N	32·9	16·5	0·4	49·8	435
D 420 lb. N	17·8	13·3	2·3	33·4	275
E 525 lb. N	24·4	14·5	3·2	42·1	351
F 210 lb. N	8·7	21·0	1·8	31·5	243
G 420 lb. N	24·9	15·9	1·2	41·9	309
H 420 lb. N	18·0	15·6	2·3	35·9	294
I 525 lb. N	21·4	16·0	1·9	39·3	328
S.E. of Means	6·3	3·6*	0·9	6·2	62
L.S.D. between treatments 5%	13·1	7·6	1·9	12·8	128

*No significant difference between treatments overall.

The treatments were as follows:—

A=Control.

B=Sulphate of ammonia (21 per cent N) Solid Soil application at 2,000 lb. per acre (420 lb. N).

C=Sulphate of ammonia (21 per cent N) Solid Soil application at 2,500 lb. per acre (525 lb. N).

D=Urea (46 per cent N) Solid Soil application at 912 lb. per acre (420 lb. N).

E=Urea (46 per cent N) Solid Soil application at 1,140 lb. per acre (525 lb. N).

F=Sulphate of ammonia (21 per cent N) 1½ per cent Foliar Spray at 1,000 lb. per acre (210 lb. N).

G=Sulphate of ammonia, 3 per cent Foliar Spray at 2,000 lb. per acre (420 lb. N).

H=Urea (46 per cent N), 2½ per cent Foliar Spray at 912 lb. per acre (420 lb. N).

I=Urea (46 per cent N), 5 per cent Foliar Spray at 1,140 lb. per acre (525 lb. N).

These results have again confirmed the highly economic responses which follow heavy nitrogen applications. This is achieved not only by increasing the total yield of fruit, but more important by raising the grade and therefore value of the crop. All treatments, with the exception of treatment F, significantly ($P = 0.05$) yielded more Grade I fruits than the control.

There was a high degree of variability between plots in each treatment, and only the higher rates of both Foliar Sprays and Solid Soil applications of sulphate of ammonia and urea (treatments C, E, G and H) gave significantly ($P = 0.05$) greater total yields of plant and fruit ratoon crops over the control. The Solid Soil applications gave the greater effects ($P = 0.01$). The overall results show that the sulphate of ammonia is more effective as a source of nitrogen than urea, but the differences are not statistically significant (1).

Bananas

Recording yields of bananas on the Thika Station has proved impossible on account of theft of fruit. Observations have been made over the last two years on the fruit quality of the different varieties. Thika is a most unsuitable climate for work on bananas, and these observations are only applicable to this area. All plants were unirrigated and made relatively slow growth due to the drought periods and the hot high winds which also caused severe ribboning of the leaves.

Variety	Origin	Height of Plant	Description of Fruit
Mutahato	Kiambu	Tall	Medium size, yellow/green in colour. Skin soft and easily damaged. Flesh pale yellow and firm. Sweet and good flavour.
Miraru	Meru/Kiambu	Tall	Long fruit, green skin, flesh white and sour taste.
Quaheuing	Nyanza	Tall	Small/medium sized fruit, yellow skin and easy to peel. Flesh firm and flavour good. Recommended.
Solio	Nyanza	Tall	Small/medium fruit, yellow skin, very soft and sweet.
Rouge	Nyanza	Tall	Medium sized fruit, yellow/red skin, flesh orange soft, good keeper, Uganda Red type.
Uganda Red	Meru	Tall	Large fruit, red skin, sweet and very soft flesh, poor flavour.

Variety	Origin	Height of Plant	Description of Fruit
Ndinuku	Fort Hall	Tall	Small/medium sized fruit, yellow thin skin, sweet firm flesh.
Nduyu	Kiambu	Tall	Medium sized fruit, yellow skin, flesh soft and sweet.
Manyoke	Nyanza	Medium	Small/medium sized fruit, greenish yellow skin, fruit prone to splitting, flesh orange and sticky. Undesirable.
Kitarasa	Coast	Medium	Small/medium size, green/yellow skin, good flavour.
Kisukari	Coast	Medium	Small fruit, thin yellow skin, easily damaged, soft flesh and sweet. Used raw.
Bukanda	Fort Hall	Medium	Small/medium plump fruit, skin orange/yellow in colour, flesh hard and tasteless. Undesirable.
Shisikame	Kakamega	Medium	Small/medium size but dull yellow in colour with brown spots, thin skin, rather soft and easily damaged, good flavour. Only used raw.
Kikuyu Green	Kiambu	Medium	Medium/large fruit, skin green/yellow, flesh white, yellowish centre. Only used raw.
Munjuu	Kiambu	Medium	Medium sized fruit, skin mustard yellow, flesh sweet but hard centre. Undesirable.
Wangae	Kiambu	Medium	Small fruit, pale yellow thin skin easily damaged, flesh white and sweet. Fruits fall from bunch when ripe. Undesirable.
Mille	Nyanza	Medium	Small/pale yellow fruit, thin skin which readily peels, very sweet, soft orange flesh, slimy taste. Undesirable.
Rachar	Nyanza	Medium	Small sized fruit, light yellow very thin skin, and prone to splitting. Flesh sweet but rather firm. Undesirable.
Sukari	Nyanza	Medium	Small/medium yellow fruit, flesh dry with brown streaks, flavour poor. Undesirable.
Kiragu Njiru	Meru	Medium	Medium sized fruit, dark yellow skin with many blemishes, flesh sticky and sweet, ripening uneven. Undesirable.
Lmange-Muzuzu	Coast	Medium	Large yellow fruit, flesh is sweet but hard centre. Undesirable.
Siallomuli	Kakamega	Medium	Medium/large, yellow/green skin, sweet and very soft flesh, Used raw.
Nyoro	Kiambu	Dwarf	Medium/large sized fruits with persistent flowers, dull yellow skin with blemishes, does not peel well, flesh yellowish and "tacky" taste. Used raw.
Chinese Dwarf	Closeburn Nurseries	Dwarf	
Gabou	Nyanza	Dwarf	Large plump fruit—mottled thick skin which peels easily. Flesh yellow, inisipid. Undesirable.
Kimilindi	Coast	Dwarf	Medium sized fruit, dull yellow with many blemishes, thick skin, flesh sweet and soft. Used raw.
Kingurue Somali	Samuru Estate, Thika	Dwarf	Small fruit with mottled yellow and thick skin which peels well, flesh pale yellow—sweet and good texture. Used raw. Recommended. (3)

Citrus

Citrus Storage Trial

A trial was commenced in January to investigate the use of certain fungicides, waxes and wraps to control the growth of green and blue mould (*Penicilliun* spp.) and enhance the sale appearance of Lisbon lemons. The fruits were stored in an underground cellar at Molo for a period of eight weeks. During the period of the trial, temperature of the cellar was 50 degrees F. and the humidity between 85 per cent and 90 per cent.

The treatments comprised fruit dipped in solution of Sta-Fresh 920. D, Sta-Fresh 920, Sofonate, Sofonate and Fernoxone and a control. Each treatment was then replicated to allow for fruit stored unwrapped, wrapped in plain tissue and wrapped in Diphenyl wraps.

There was no significant differences between treatments for attacks by storage rots. Fruit dipped in Sta-Fresh 920 whether wrapped or not was the best in appearance, whilst this dip combined with wrapping in a Diphenyl wrapper gave the least loss in fruit weight though this was not significant (5).

LEMON EXPORT TRIAL

In co-operation with the K.F.A., a trial consignment of lemons, of the variety Lisbon, grown on Bahati Estates, were exported to England by sea during November, 1960. The fruit was hand-picked and packed on the farm in boxes holding 25 lb. net. Messrs. T. J. Poupart Ltd., to whom the lemons were consigned, reported that they were some of the finest lemons they had seen for a long time. The lemons were sold for Sh. 25 per crate, showing that fruit of suitable quality can be grown in Kenya and be successfully exported to the United Kingdom (5).

Macadamia Nut

PROPAGATION

All the macadamia trees in Kenya have in the past been propagated from seed. These seedlings are very variable in growth and behaviour and of little commercial value. In order to produce a uniform type of tree for commercial production, a number of individual trees, which had already cropped and exhibited the best characteristics, were selected for vegetative propagation. Since there was no literature available on the propagation of macadamias, an initial trial was laid down to determine the best type of cutting material to use. The rooting trial was carried out in a lean-to glasshouse which was lightly shaded with sisal poles. Cuttings were taken from an eight-year-old seedling which was just in flower.

All cuttings were 4 in.-6 in. long and consisted of three nodes. The leaves from the middle and basal nodes were removed and the bases dipped in Seradix 2B. The cuttings were prepared on 18th September, 1961, and planted into a rooting medium consisting of equal volumes of sand and coffee parchment husks. Intermittent mist spray was applied by an N.A.I.E. Artificial-leaf Propagating Unit. The cuttings were examined on 1st February, 1962. The results were as follows:—

Part of Shoot	No. of Leaves	Total No. Cuttings	Rooted	Callus	Dead	Rooted
						%
Apical	3	58	30	27	1	51·6
Middle	½	37	2	3	32	5·4
Middle	1	14	5	5	4	35·8
Middle	2	44	12	17	15	27·2
Basal	0	49	0	0	49	0·0
Basal (split)	0	11	0	0	11	0·0

No success was obtained with the basal portion without leaves, and in general it would appear that the growing of shoots from cuttings is unsatisfactory. The apical shoots gave the best results, and the middle portions which had one and two leaves rooted better than those with only half a leaf.

The poor rooting in general was considered to be due to the cuttings having been taken when the tree was in an active stage of growth, and furthermore the mist propagating unit was out of order for several weeks during the later part of the trial. However, although this was not a statistical trial, the results and observations point the way for future work (1) and (2).

Strawberries

Fertilizer Trial

This trial is now complete and the crop results are shown in Table 2.

Table 2—Yields over the Three Crops as Lb./Acre

Treatments	O	N_1	N_2	P_1	P_2	K_1	K_2	Mean
First Crop ..	2,224	2,318	1,742	2,318	2,452	1,554	2,452	2,156
Second Crop ..	844	884	750	750	884	750	750	801
Third Crop ..	566	506	446	711	588	515	717	579
Totals ..	3,634	3,708	2,938	3,779	3,924	2,819	3,919	3,536

No significant treatment effects have come out of this trial although such high fertilization levels have been applied. There were original dressings of sulphate of ammonia at 400 lb. and 800 lb. per acre, double superphosphate at 100 and 200 lb. per acre and sulphate of potash at 100 and 200 lb. per acre. Before taking the third crop the treatments were re-applied. The soil in which the trial was planted was straight out of young cypress forest. Because of the excellent performance of newly imported runners from Britain on the same soil, and of other data available, it is considered that the type of planting material used in this trial was responsible for the very poor yields. The material consisted of splits from three-year-old Cambridge Early Pine plants.

The gross return per acre, with irrigation, over the 29 months, which represented the period from planting to final harvest, was Sh. 4,082/40. The entire crop consisted of second-grade fruits of which only 61 per cent was fit for sale. Production costs were not maintained but were estimated at Sh. 5,000 per acre, which makes the yield from this trial completely uneconomic. Although production costs are high this is to be expected for a highly intensified high priced crop such as strawberries, especially when the average gross return per pound is about the Sh. 2 mark. From plantings of newly imported runners, and from other data available at this station, the saleable crop should be in the region of 14,000 lb. per acre over a 29-month period (5).

Costing/Production Trial

This trial was completed on 1st August. The yields showed a marked fall with each successive crop, the exception being in the third crop of the August/October period; this may have been due to the very favourable rains which occurred during 1960 as compared to previous years. The April/June period produced the highest yield and as a result the highest return.

The three-year results are as shown in Table 3.

Table 3

Cropping Period	1st Crop	Net Loss or Profit	2nd Crop	Net Loss or Profit	3rd Crop	Net Loss or Profit	Total Net Loss or Profit
	lb./acre	*Sh.*	*lb./acre*	*Sh.*	*lb./acre*	*Sh.*	*Sh.*
1st Aug. to 1st Oct...	1,970	+279	1,200	−1,199	2,260	+836	−83
1st Oct. to 1st Dec...	5,005	+6,106	1,790	+134	1,780	+140	+6,380
1st Dec. to 1st Feb...	4,075	+4,321	2,620	+1,527	940	−1,698	+4,150
1st Feb. to 1st Apr...	6,660	+9,284	2,520	+1,336	185	−3,148	+7,472
1st Apr. to 1st June..	10,360	+16,388	4,440	+5,022	2,050	+433	+21,843
1st June to 1st Aug...	4,080	+4,331	3,650	+3,505	2,220	+759	+8,595

N.B.—Costings were based on a gross return of Sh. 2/50 per pound; a fixed capital outlay of Sh. 8,067 per acre for manure, planting material, etc., written off over three years; fixed current expenditure of Sh. 814 per acre for irrigation, weeding and deflowering, and a charge of 88 cents per pound for picking, packing and H.C.U. commission, etc. (5).

Comparison Trial (*Controlled versus Uncontrolled Cropping*)

This trial was planted on 4th October, 1960, to compare the yields of fruit from plants allowed to crop until exhaustion, with no deflowering against plants deflowered for eight months and cropped for two months, as is current commercial practice.

The yields and profits up to 31st December, 1961, are given in Table 4.

Table 4

Treatment	Mean Yield	Net Profit	
	lb./acre	*Sh. cts.*	
Controlled Cropping ..	3,909	4,002 59	Cropped for 2 months.
Uncontrolled Cropping	7,518	11,478 27	Cropped for 10 months.

N.B.—The costs and returns were based on figures as given for preceding trial.

Packing

Waxed cardboard punnets have now been used for nearly a year for all the soft fruit marketed locally by the Molo station. During this time the price returns have been equal to that of local growers using chip punnets. The cardboard punnets are approximately 18 cents per unit cheaper than the chip punnet, effecting a saving of approximately Sh. 400 per acre (5).

Onions

Of the varieties tested, only Bombay Red, Bellary, Round Red and Egyptian Flat produce an onion which has the qualities required by the local market. The yield comparisons between the three red varieties have been inconclusive. The suitability of Egyptian Flat for Kenya conditions must be regarded as not proven until further trials have proved the reliability of its bulbing (1) and (4).

Set Production

Production of onion crops from sets as opposed to seed would enable considerable expansion of onions as a cash crop. In many otherwise suitable areas, rainfall is too uncertain to make production from seed anything but a gamble. Several trials carried out to date have failed to show how sets can be produced economically under local conditions, though this is partly due to unfavourable weather conditions during the year. Investigations are being continued.

Tomatoes

Four samples of F1 hybrid tomato varieties were received from Japan and were put to trial on an observational basis. The seed was sown on 17th June, 1961, and transplanted at a double-row spacing of 6 ft. × 3 ft. × 2 ft. on 17th

August, 1961. Harvesting of the fruits commenced on 2nd November, 1961, and finished on 27th December, 1961. The total yields of fruit of each hybrid were as follows:—

	Hybrid	Yield
		Tons/Acre
F1	1	6·9
F1	2	5·8
F1	3	5·6
F1	4	6·0

There was very little difference between the four hybrids in earliness or yield. All had fairly large fruits which ran from four to five fruits per pound. The fruits were scarlet red in colour, and globular to deep oblate. Of the four hybrids FL 1 had fruits which were smoother and rounder than the others. All hybrids were free from cracks and the fruits were fleshy.

The conclusion is that none of the varieties were exceptional in their performance compared to the varieties already being grown commercially in Kenya, and would not offset the high cost of the seed (1) and (2).

Mushrooms

Compost Trial

This trial was a follow-up of a previous trial in which a synthetic compost was used. The compost used in this trial was pig manure based on wheat straw. Added to the four tons of compost was 42 lb. triple superphosphate, 85 lb. blood meal, 105 lb. gypsum and 140 lb. lime. The trial covered a period of 7½ months. The cropping period was four months. Yields from 107 sq. ft. of bed were as follows:—

	lb.
1st month	62
2nd month	71
3rd month	51
4th month	39
Total	223

The average yield per square foot of bed was 2.08 lb. which is just above the minimum average obtained in Britain. An average wholesale price of Sh. 3/90 per pound was obtained for the crop. Actual production costs were Sh. 491/93 while the gross return was Sh. 869/70.

Flies proved to be very troublesome and persistent pests and were difficult to control. Pyrethrum dust was applied every third day and an aerosol spray containing pyrethrum was also used to spray walls and alleyways between beds. Aerosol coming into contact with the mushrooms tends to stain them.

Because it was noticed that cropping was better where the compost was wetter, because of rain leaking through the roof, it was decided to keep the beds more moist than in the previous trial. Under Kenya conditions the indications are that the compost casing requires much more moisture than is the case in more temperate climates (5).

Capsicum

A small single plot observational trial was put down in August, 1960, at the Kitale substation and was completed in early January, 1961. The variety was Neapolitan and the yield, based on a 2 ft. × 2 ft. spacing, was at the rate of 18,096 lb. per acre or 1.57 lb. per plant. Manurial treatment was FYM at 10 tons per acre and double superphosphate at 1½ cwt. per acre. The time from transplanting to first harvest was two months. Irrigation was provided where necessary. At 50 cents per pound this could become a £350 per acre crop net. The outlet for such a crop must, however, be relatively limited (5).

Peas

Sowings were made of three processing varieties during September, 1960, to investigate the yield and commercial prospects. The peas followed potatoes, which had received triple superphosphate at the rate of 2 cwt. per acre, and no further fertilizer or manure was applied. Three-quarters of an acre each of the varieties Unica and Fertila and one-quarter of the variety Alaska were sown at a spacing of 7 in. between the row and 1 in. apart in the row.

The dry pea yield results per acre were as follows:—

Variety	*Yield lb./acre*
Unica	837
Fertila	976
Alaska	501

Alaska is slightly earlier than the other two varieties but is a poor cropper, as was indicated in an earlier trial. Rainfall during the trial period was 7.40 in., which was supplemented by a further 4 in. of irrigation. Production costs on an acre basis were Sh. 483/66. Yields are low compared with results previously obtained at Molo. This is considered to be due to low fertility of the land on which the trial was planted (5).

Asparagus

Fertilizer Trial

The third-year crop results and the average crop over a three-year cycle is as follows:—

Table 6

(*Mean of* 2 *Plots*)

Treatments	FYM	NPK	N	Mean
Yield/acre/lb., 1961 ..	565·5	531·7	499·2	562·9
Average yield over 3 years cropping period.. ..	672·1	528·58	526·63	575·77

This year's crop results were similar to the previous two in that the FYM treatment considerably increased yields over the other two fertilizer treatments. This pattern also shows in the average crop yields for three years which also indicates the remarkable similarity in the yield from the fertilizer treated plots. The overall yields in this trial are low apparently due to poor soil fertility. This demonstrates the importance of planting asparagus only on the most fertile soils.

The annual treatments are:—

(*a*) FYM at 1 ndebe per 6 ft. of row (1 ndebe=4 gallon can).

(*b*) Sulphate of ammonia at 400 lb., plus single superphosphate at 400 lb., plus sulphate of potash at 200 lb. per acre.

(*c*) Sulphate of ammonia at 400 lb. per acre.

VARIETY TRIAL

The second harvest results made during April/May are as follows:—

Variety	Lb./Acre	Crowns Surviving
		%
Purple Argenteuil	567	31
Connovers Colossal	756	100
Battersea Giant	824	90

Purple Argenteuil yielded 40 lb. less this year whilst Connovers Colossal produced approximately 40 lb. more (5).

Geraniums

PROPAGATION TRIALS

(*a*) An observational trial was put down to investigate further the value of applying a protective fungicidal solution before the cutting material was bruised, in this case during transit from the Scott Agricultural Laboratories (although it could well be in transit from the field). Scoring was carried out eight weeks after planting, all cuts were made at the node and cuttings were prepared by semi-skilled labour using secateurs. Dipping in Captan was carried out prior to dipping in Seradix.

The results were as follows:—

TABLE 7

Treatment	Rooting
	%
1. Cuttings dipped at S.A.L. in 0·5% Captan	44·75
2. Cuttings dipped at S.A.L. in 0·5% Captan plus Seradix No. 2 ..	71·75
3. Cuttings dipped at Molo in 0·5% Captan	25·80
4. Cuttings dipped at Molo in 0·5% Captan plus Seradix No. 2 ..	44·60
5. Cuttings untreated	16·00
6. Cuttings dipped in Seredix No. 2	38·60

The cuttings were planted on 7th November, 1960, and the scoring took place on 7th January, 1961. Rainfall during this period was 3.76 in. over 15 days, irrigation being provided when required. In all the plots many of the cuttings were just showing growth except for treatment 2 where the growth was outstanding compared with the other plots.

From the three trials carried out so far it would appear that the use of the Captan or Seradix alone is not sufficient and they must be used together to provide a satisfactory result. The fungicide provides some measure of protection from fungal attack whilst the hormone aids early rooting.

(*b*) Following the above trial a further experiment was commenced to determine if the depth of planting or the rooting medium affects the rooting.

The trial was commenced on 1st May and completed on 26th June. Rainfall during this period was 7.05 in. The results are as shown in Table 8:—

TABLE 8

Plot	Treatment	Depth	Take	Per cent
		inches		
A	200 cuttings in sand frame and shaded	2	192	96
B	200 cuttings in sand frame and shaded	4	178	89
C	200 cuttings in the open ground, unshaded..	2	167	83
D	200 cuttings in the open ground, unshaded..	4	183	91

Note.—The cuttings in all plots received a standard treatment of dipping in a 0.5 per cent Captan dip followed by application of Seradix No. 2.

ESTABLISHMENT TRIAL

Cuttings which had been rooted in the sand frame were transplanted at 10-day intervals in order to determine if delay in transplanting would affect the establishment in the field. At each planting half the rooted cuttings were immersed in a 0.5 per cent Captan dip. The first planting took place 60 days after planting the cuttings in the sand frame, and the last, 100 days. There was no apparent difference between the treatments or by using Captan (5).

Dioscorea

The diosgenin assay figures for the two-year-old dioscorea tubers despatched to Messrs. Boots Ltd. in Britain were received in June.

A summary of the mean weight of tubers per plant (oz.) and the diosgenin content per sample at the end of one year and two years' growth at Molo, for the varieties *D. glauca, D. balcanica* and *D. nipponica,* are as follows:—

Variety	Mean Weight in oz. per Plant	PER CENT DIOSGENIN	
		Wet	Moisture Free Basis
D. glauca—			
1st year	4·59	0·54	1·54
2nd year	6·70	0·70	1·90
D. balcanica—			
1st year	16·40	0·57	1·64
2nd year	22·60	0·65	1·85
D. nipponica (1)—			
1st year	1·68	0·42	1·29
2nd year	2·30	0·55	1·30
D. nipponica (2)—			
1st year	5·05	0·51	1·52
2nd year	3·60	0·60	1·55
D. deltoidea—			
10 months old	—	—	3·85

The 10-month-old tubers of *D. deltoidea* were assayed before the weight was recorded but the percentage diosgenin on a moisture-free basis for this species was a great deal higher than for any of the other varieties so far assayed (5).

References

The officers responsible for carrying out the work in this report are designated by numbers at the end of each section.

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T. H. JACKSON,
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ANNUAL REPORT OF THE SENIOR RESEARCH OFFICER (PYRETHRUM)

1. Meteorological

Detailed meteorological records for the different pyrethrum stations will be attached to a more comprehensive report to be published by the Pyrethrum Board of Kenya.

A long and severe dry season was experienced in most areas before rains broke again in April. Pyrethrum suffered considerably but as the result of the April showers fairly prolific flowering was experienced in June. From the middle of May onwards rains became scantier again, flower yields declined and the newly planted crop started to suffer. Not until August were heavier rains recorded; these stimulated fresh bud initiation. However, flower production did not rise to the expected level in all areas; cloudy weather during August, October and November encouraged bud and flower diseases which caused losses until January, 1962. Some sites at the higher altitudes as for example the Grassland Station, Marindas, seem to have suffered less and produced excellent crops later in the year, which is difficult to understand. The rainfall during the last quarter of the year was exceptionally heavy, so much so that the year's total was eventually well above the average in most districts. This caused waterlogging in many cases especially on the Kinangop, with consequent loss of plants. However, as the result of larger licensing quotas and bigger acreages planted in 1960, there was a further increase in flower production of 3,833,655 lb., making the total deliveries for the year 22,917,001 lb.

The adverse growing conditions were reflected by the poor pyrethrins content of 1.26 per cent, the lowest ever recorded. Although the toxic content rose slightly in September, probably because of a drop in mean temperatures, it reached a low level again from October to December. It was observed that, contrary to expectations and former records, the mean temperatures were fairly high during these months in spite of heavy rain and cloud cover. This phenomenon is difficult to understand but might explain the low analysis readings. It should also be remembered that most pyrethrum plants started the season under strained conditions as the result of a long and exacting drought.

During the wet and cloudy months, August, October and November, bud diseases were widespread, mainly the physiological form but *Ramularia bellunensis* was also observed. Isolated outbreaks of thrips occurred towards the end of the season.

2. Experimental Work

(*a*) Fertilizer Trial

A comprehensive report of all previous work on fertilizers and manures has been prepared and will be published in the agricultural press.

During 1961, ten experiments were either maintained or newly planted. Most of these were designed to investigate further the phosphorus and calcium responses of a wide range of soil types. The Senior Soil Chemist started studies on nutritional problems in sand culture.

No field trials have finished flowering and they are still being harvested at the time of writing this report. However, preliminary results can be given.

In an experiment at Marindas with different types of phosphatic fertilizers 1,008 lb. per acre hypo-phosphate and 1,008 lb. per acre Seychelles guano produced the best responses, closely followed by 224 lb. per acre double superphosphate. A dressing of 448 lb. double superphosphate was no more effective than 224 lb., thus confirming previous findings that the optimum applications lie between 150 and 200 lb. per acre double superphosphate.

Following a grass ley at Molo, phosphorus dressings increased the pyrethrum yields by almost 50 per cent. It appears that the export of phosphorus through the grazing animal is fairly heavy and that it must be replaced.

The whole aspect of nutrition has been tackled from a slightly different angle in a new large experiment at Marindas in which six major elements (calcium, nitrogen, phosphorus, potash, magnesium and sulphur) are used in combination and minus one element. So far, only phosphorus has given any reaction but the trial will be continued for two more seasons.

At Thomson's Falls, 200 lb. per acre double superphosphate have produced a yield increase over three seasons of 856 lb., and three tons per acre ground limestone one of 223 lb. ($P = 0.01$ and 0.05 respectively).

(*b*) Cultural Trials

The irrigation experiment at Molo showed a clear response to overhead watering (143 lb. per acre) during the first dry half of the year. Later, no reaction was recorded. On the poor soil of the Molo nursery phosphorus also had an effect. The plots which were cut back for a second time in July yielded considerably less than those treated in the usual manner.

The rotation trial at Ol Joro Orok confirmed the findings of the previous two seasons, i.e. poorer yields on land continuously kept under pyrethrum compared with pyrethrum rotated with other crops, especially grass leys. The necessity for phosphate applications on land that is bearing pyrethrum repeatedly also became apparent. A detailed report on the results accumulated to date will be published shortly.

Mr. S. D. Hocombe, Botanist of the Tropical Pesticide Institute, Arusha, again gave valuable assistance in the layout and execution of trials with chemical weed-killers. For pre-emergent weed control Simazine at the rate of not more than 1 lb. per acre sprayed on newly planted seedlings and 2 lb. per acre on splits, with Kloben, proved satisfactory. Also several triazines, Amoben, Alipur and Eptam, showed promise. Detailed reports on these trials have been produced.

3. Plant Breeding

Routine work aimed at the production of new hybrids continued. Eighty-five single plant selections were made and approximately 300 were under examination. More tested clones were bulked up for further breeding purposes and there are now about eight acres of these plants on the various stations. In 30 isolated plots bi-clonal crosses (hybrids) were produced, while the "Sugar Beet" breeding systems were continued in 14 larger plots. A large number of new hybrids were tested in 23 yield trials distributed over a wide range of the pyrethrum growing areas. As a result of previous trials it was decided to issue the following hybrids: — M.51, M.54, M.55, M.56, M.73, 0.1, 0.3, 0.21 and 0.22. Seed production fields were established for these on approved farms, but due to adverse weather conditions these new plots yielded no seed in 1961. Older seed fields too suffered from drought and later from excessive rain and cloud, so that normal quantities of seed were harvested only in the first months of the year; later material was of very poor

quality and had to be discarded. The absence of pollinating insects during the wet and cloudy months was probably largely responsible for the failure of the seed harvest. The total deliveries to the Pyrethrum Board amounted to only 4,320 lb., compared with 8,493 lb. in 1960. At the moment, however, the prospects for seed production have greatly improved. Thirty-seven hybrids produced on some 40 seed fields are now on issue. It is planned to reduce this number gradually and to concentrate on the most important hybrids. A list of available hybrids with recommendations for the different pyrethrum areas has been issued to all growers.

The Plant Breeder started trials on rapid vegetative propagation of clones and a new line of polycross breeding. The late rains in November and December were of great assistance in establishing these new plots. He also made another 500 single plant selections in the latest hybrids.

U. KROLL,
Senior Pyrethrum Officer.

ANNUAL REPORT OF THE OFFICER-IN-CHARGE SISAL RESEARCH

Meteorological

	Rainfall		*Average Previous 20 years*	
	Inches	*Days*	*Inches*	*Days*
January	0·22 in	2	1·23 in	3·3
February	0·85 in	4	1·38 in	2·7
March	3·77 in	11	3·68 in	7·7
April	6·01 in	11	8·40 in	15·0
May	0·68 in	6	5·20 in	11·4
June	0·42 in	3	0·94 in	4·6
July	0·08 in	3	0·62 in	3·7
August	0·37 in	7	0·63 in	4·4
September ..	1·20 in	8	0·66 in	3·2
October	13·28 in	15	1·74 in	4·9
November ..	16·48 in	22	5·52 in	14·1
December ..	4·87 in	7	3·02 in	8·9
TOTAL ..	48·23 in	99	32·84 in	83·7

The year started with a severe drought and ended with exceptional rains in October and November which precipitated 29.76″. This was the heaviest rainfall ever recorded at the Station in two consecutive months.

Investigational Work in Progress

NURSERY TRIALS

The seventh cycle of the Nursery Manurial Trial was lifted in April, 1961, and the eight cycle planted in June. This trial area has been under nurseries continuously since November, 1950, and is still producing reasonably good plants.

After the sixth cycle, lifted in December, 1959, soil-samples were taken from each plot. The pH varied from 4.2 to 5.1 with 27 of the 32 plots lying within the range of 4.2 to 4.6. All the plots with a higher pH were those which had received sisal waste either as a mulch or dug into the surface. The calcium status of the soil was reduced to a low level. The Ca m.e. per cent in 22 of the 32 plots was between 0.2 and 1.4 and, with one exception (4.8 m.e. per cent), the rest ranged from 2.0 to 3.8 m.e. per cent. The whole trial area was therefore limed at the rate of two tons of agricultural lime per acre; lime is not a factor in the trial. The phosphate in the soil had also reached a very low level; the phosphate treatment of 180 lb. double superphosphate per acre was increased in the seventh cycle to 370 lb. This was reflected in a significant response, the average plant weight being increased from 2.8 lb. per plant to 3.4 lb. A response to phosphate of this magnitude was obtained only once in the previous cycles.

As before, the biggest response was obtained from the sisal waste application of 30 tons per acre and again the effect of digging the waste into the top soil (C) was better than leaving it on the surface (M). The effect of the interaction of these two treatments can be seen in Table I.

TABLE I—MEAN WEIGHT PER PLANT IN POUNDS

No Waste	30 Tons Waste		60 Tons Waste
	M	C	CM
1·77	3·19	3·57	3·89

Over the seven cycles nitrogen was applied at planting on four occasions with a second later application. Positive responses to nitrogen resulted from these treatments. In three cycles nitrogen was withheld until 5-6 months after planting, followed again by a later application. No significant response to nitrogen was obtained in these three cycles.

The fifth cycle of the Nitrogen and Lime Nursery Trial was lifted in March, 1961. The results did not show statistically significant differences. From analysis of soil samples it appears that the lime treatments have depressed available nitrogen and phosphorus. The application of sulphate of ammonia is associated with an increase in available magnesium and in acid extractable phosphorus but not at a statistically significant level. The urea application is associated with the most intense acidities and lowest calcium values in the soil.

On preliminary investigation it appears that the idea of smother nurseries has some virtue. Small bulbils are planted very close together, say 2 in. to 3 in. apart, in bands 18 in. wide, anticipating that such spacing may lend itself to mechanical lifting. The weak plants die in the smother nursery and, when the remaining plants are lifted after 3-4 months, they are easy to sort before planting into nurseries at the normal spacing of 2 ft. × 9 in. In the first experiment smother plants have grown very evenly and with negligible loss compared to the normal loss of about 10 per cent when planted direct into ordinary nurseries. The area for a smother nursery must be free from weeds before planting as only weeding by hand, without tools, is possible after planting; progress in new herbicides tends to reduce the seriousness of this problem.

Plant Management Trials

In the Double *versus* Single Row Trial, planted in April, 1952, three populations of 1,600, 2,000 and 2,400 plants per acre, two row spacings of 11 ft. and 13 ft. and double rows 3 ft. apart against single rows are being compared in factorial design combination.

The 12 plots with only 1,600 plants per acre have poled out while six plots remain with 2,000 plants and 10 plots with 2,400 plants per acre. The leaf length, the average weight per leaf cut and the number of leaves needed per ton of fibre have varied very little. The 1,600 plant population has produced 5.67 tons of fibre; the 2,000 plant population, at 79 per cent, poling, has produced 6.14 tons, while the 2,400 plant population, at 52 per cent poling, has produced 6.32 tons. Final differences will be very substantial.

The differences between the row spacings of 11 ft. to 13 ft. emphasize the importance of within-the-row spacing. By reducing the row spacing from 13 ft. to 11 ft. the distances between plants within a row have been increased depending on the plant population and these increases in interplant distance have resulted in more rapid growth. This point is further emphasized when double rows are compared to single rows. The indications are quite clear; the higher the plant population the more important it is to plant in double rows in order to obtain sufficient interrow spacing.

The effects are illustrated in Table II which gives the results at a cutting taken in April.

TABLE II—PLANT POPULATION

Plant Population	1,600		2,000		2,400		L.S.D. P=0·05
Rows	Single	Double	Single	Double	Single	Double	
Distance in line	2′	3′ 6″	1′ 9″	2′ 9″	1′ 5″	2′ 3″	
Leaf count ..	213	216	209	211	198	206	5
Leaves cut ..	172	182	150	157	117	146	11
Tons fibre ..	5·69	5·65	5·85	6·43	5·62	7·02	0·67
Poling % ..	84	81	74	85	38	66	9
No. of thousand leaves per ton fibre	49·4	50·3	49·8	50·0	49·8	51·8	2·7

Fertilizer Trials

The long drought period lasting from April, 1960 to October, 1961 drastically reduced the number of new leaves per plant in the trials. The results indicate that the prolonged drought has delayed leaf production by about a year.

In newly started trials, planted during the latter half of 1960 and the first months of 1961, there is evidence that the plants treated with sisal waste have stood up to the drought considerably better than untreated plants. Moisture retention was increased by the applications, amounting to about 50 tons of sisal waste per acre, especially when the waste was concentrated into 6 ft. strips under the young sisal plants. The waste disappears after a couple of years, so that the effect was not evident in the older trials. The results for a few of the trials are given below.

The two fertilizer trials planted in 1952 on Thika red soils, have grown comparatively slowly and in 1961 reached approximately 20 per cent poling only. The biggest effects in these trials have been obtained from the application of sisal waste. The control has so far yielded only 2.57 tons while the plots receiving waste have yielded 3.95 tons of fibre. The effects of small nitrogen applications and of applications of phosphate and lime have been negligible. Where a vigorous grass like Molasses grass (*Melinis minutiflora*) was interplanted at the commencement of the trials and not grazed but only occasionally slashed, the result has been a drastic reduction in the number of leaves grown since planting. This reduction has been in the region of about 20 leaves per plant over nine years. The treatment has resulted in a reduction of fibre yield from 3.70 tons to 2.47 tons. Another factor in reducing fibre yield has been the number of short leaves unsuitable for decortication in the interplanted plots.

In another fertilizer trial planted at Thika in 1954 a number of interesting results are being obtained. The responses to the two rates of phosphate is small and the responses to lime applications of two and four tons per acre are negative and need more study. The leaf counts for sisal waste and nitrogen treatments, each at three levels are given in Table III. The record was made in July.

TABLE III—MEAN LEAF COUNTS PER PLANT FOR SISAL WASTE AND NITROGEN TREATMENTS

	No Waste	2 x 25 Tons	2 x 50 Tons	Mean N
No nitrogen	167	180	189	179
30 lb. N x 8 application ..	186	180	193	186
60 lb. N x 8 application ..	191	199	205	198
Mean for waste	181	186	196	

Fibre yields up to July 1961, after four cuts, are given in Table IV. Poling percentages are in brackets.

TABLE IV—FIBRE YIELDS IN TONS PER ACRE

	No Waste	2 x 25 Tons	2 x 50 Tons	Mean N
No nitrogen ..	1·84 (0·5%)	2·75 (12·2%)	3·21 (9·4%)	2·53 (7·4%)
30 lb. x 8 appl. ..	1·90 (6·1%)	2·45 (1·7%)	3·49 (10·6%)	2·80 (6·1%)
60 lb. x 8 appl. ..	3·29 (11·1%)	3·69 (10·0%)	4·32 (21·7%)	3·45 (14·3%)
Mean waste ..	2·68 (5·9%)	2·96 (8·0%)	3·67 (13·9%)	

The indications are that either or both of these fertilizers give a considerable benefit.

Similarly, results have been obtained in the fertilizer trial planted in April, 1954 on the light sandy soils of Kampi ya Moto district. All nitrogen and waste applications were completed in April, 1957 and the yields of fibre for these treatments are given in Table V. The poling percentages are in brackets. The nitrogen was applied in six doses of 60 lb. N each (N_1). The yields are those at the latest cut in August, 1961.

TABLE V—YIELD OF FIBRE IN TONS PER ACRE FOR SISAL WASTE AND NITROGEN TREATMENTS

	W_0 No waste	W_1 12·5 tons x 3	W_2 25 tons x 3	W_3 50 tons x 3	Mean N
N_1	4·78 (79%)	4·61 (76%)	5·27 (91%)	5·53 (100%)	5·06 (86%)
N_0	1·17 (Nil)	1·58 (12%)	2·36 (32%)	3·62 (64%)	2·18 (7%)
Mean W ..	2·97 (39%)	3·10 (44%)	3·82 (61%)	4·59 (82%)	

Mulching

In October, 1960, a trial was planted in which polythene sheets, 72 in. wide, were used as a soil cover. The sisal plants were planted into holes punched in the polythene, three gauges of which were compared. The growth of sisal was recorded in October, 1961, and the results are presented in Table VI.

TABLE VI—MEAN LEAF COUNT PER PLANT

No cover	POLYTHENE		
	250 gauge	500 gauge	1,000 gauge
14·8	20·6	22·4	22·8

No handweeding was necessary during the year in the polythene plots and the soil has been kept moist and cool. The cost of the treatment is too high at present, but the trial may lead to more studies on soil covers round the base of the plants.

Herbicides

PHYTOTOXICITY TRIALS 1960/1961

The phytotoxicity trial which tests the effects of C.M.U., 2,4-D Ester, 2,4-D Amine Salt, and M.C.P.A. on bulbils in a nursery at different rates and times of application was lifted in February, 1961. It was found that M.C.P.A. was the only one of the four chemicals tested which is safe and can be recommended for use in bulbil nurseries. C.M.U. was found to be safe, but the expense of the material precludes its use.

This trial area was replanted, but this time only grass killers were used. Tests in 1957 with Dowpon (2,2-dichloropropionic acid with a wetting agent) had shown that this material was safe only when applied at sub-lethal doses for grass; however, since that time new formulations of the material have come on the market so a second series was laid out to compare and test the effects of two of them against Dowpon, viz.: Basfapon (Sodium salt of 2,2-dichloropropionic acid without a wetting agent) and Basinex (2,2-dichlorobutyric acid). These three formulations were compared, both sprayed on the bulbils direct and not on the bulbils, but around the root area only. They were also sprayed at different intervals (3 weeks, $2\frac{1}{2}$ months and $5\frac{1}{2}$ months after planting) and at different dosage rates ($2\frac{1}{2}$ lb., 5 lb., 10 lb. and 20 lb. per acre). The final assessment clearly showed that once again Dowpon could not be recommended for post planting treatment of bulbils in a nursery. Neither could Basinex as it caused "dieback" from the leaf tips, chlorosis and a growth check. Basfapon, however, did not damage the bulbils at 5 lb. per acre and growth disturbance was quite negligible at all levels. It would therefore seem that the sodium salt of 2,2-dichloropropionic acid without a wetting agent can be used in bulbil nurseries after planting, at 5 lb. per acre and above if necessary.

WORK WITH SOIL HERBICIDES 1961

A great variety of herbicides have been tested at Thika since 1950; nearly all have been weed eradicators and most of the more effective grass and weed-killers have been impracticable in growing sisal because of their toxicity to the crop. Recommendations to date have been confined to preplanting treatments with the sodium salt of 2,2-dichloropropionic acid and M.C.P.A., followed by low dose repeat treatments where necessary after planting, usually spot-spraying only. However, the arrival of Simazine has altered the position, permitting a new and useful approach which involves keeping clean land weed free.

Following on a promising trial with Simazine in 1960, a number of further trials were laid down in 1961. Triazine Analogues (following on from the Simazine "mother compound") were tested, mainly for phytotoxicity, in field sisal. Atrazine, Methoxypropazine, Simetryne and Ametryne (plus Simazine) were included alone and in combinations with Dowpon and Basfapon. The chemicals were applied in April, both direct over the sisal and secondly round the root areas on the soil only. Each plot was one-fifteenth acre in size and 19 separate lines of double row sisal were used in each plot. The results showed that phytotoxicity was fairly low in all treatments, but Simetryne + Dowpon was more toxic than other treatments, followed by Ametryne + Dowpon. Further tests have been initiated in bulbil nurseries with Atratone, Prometone, Prometryne, Atrazine, Simetryne (plus Simazine) alone and in combination, but final results are not available for these.

The Phenyl Urea persistent soil herbicides Diuron, Monuron and Neburon were tested on bulbil nurseries and compared to the Triazines, alone and in combination. Other herbicides tested alone and in combinations with these were Aminotriazole, M.C.P.A., C.M.U., Eptam, Reglone, Paraquat, Amiben and Alipur. All, with the exception of Reglone and Paraquat, were sprayed over the bulbils on bare soil at the beginning of November. Reglone and Paraquat, being foliar desiccators, were sprayed after weed and grass emergence in December. Preliminary results are available.

At the end of the year Diuron showed a near complete control of all vegetation and it was not very toxic to the bulbils. Monuron plus Aminotriazole and Diuron plus Aminotriazole were rather toxic but showed a very good control of all vegetation. Monuron plus Dowpon and Diuron in the same combination showed complete control of all vegetation at the end of the year but were both rather toxic. Amiben controlled grass very well, but not broad leafed weeds; it was non-toxic. Simazine plus Aminotriazole gave good weed control and fair grass control, but was rather toxic. M.C.P.A. plus Diuron and M.C.P.A. plus Simazine gave very good weed control, only fair grass control and the Simazine combination was rather toxic, a phenomenon which needs further investigation. Paraquat gave an immediate 100 per cent top kill but as it has no residual control effect, this weedkiller will have to be tested together with soil persistent herbicides. A "cocktail" spray including a low dose of Dowpon, Aminotriazole, Simazine and M.C.P.A. gave excellent control of all vegetation and was not very toxic. The final assessment will be made when the plants are lifted, since the varying degrees of toxicity are not in themselves decisive.

Granular formulations of herbicides were tried for the first time in 1961. Dowpon granules, Basfapon granules, Amiben granules, Eptam granules and Alipur (HS55) granules were rather ineffective. Toxicity to bulbils was low in all gave a good control of grass and a fair control of other weeds when applications were made on bare soil. Eptam granules gave only a fair weed control and Alipur (HS55) granules were rather ineffective. Toxicity to bulbils was low in all cases and as there is no spray drift hazard, these formulations may be very useful in bulbil nurseries and young sisal fields as a "follow up" treatment. Further field trials are in progress but, since they were initiated towards the end of the year, it is too early to report on them.

Plant Improvement

Selection from Agave Sisalana

Bulbils from selected mother plants are under observation. They are approaching maturity, but insufficient plants have poled for an assessment to be made of the relationship between the original plants and their progeny.

Sisal Seed Production

Studies on the production of viable sisal seed were carried out in 1961, as a preliminary to future work. Plants which had started poling together had their poles chopped off level with the top leaves at the end of May. By October some flower setting had taken place and at the end of the year a few formed fruits remained on the plants. In general the studies indicate that the time when the pole is cut is fairly critical, that the micro-climate round the flowers and developing ovary may be important, that pollination of the flowers does not appear to affect the formation of the abscission layer. Treatments with alpha-napthaleneacetic acid were inconclusive.

Hybrid Reproduction

The Hybrid nurseries which were planted out in October, 1960 are surviving, but with many gaps due to the drought.

Hybrid Seedlings

Seed collected from 11 Hybrids has been planted in raised well drained beds some three feet wide. The best germination was obtained by scattering the seeds on the surface and lightly raking them in. They were then covered with a 2-3 in. mulch of grass and kept well watered. It was found that lightly rubbing the edges of the seedcoat off the black seed decreased its wind resistance and so winnowing the seed from the unfertilized ova was possible. This rubbing did not appear to affect germination as seedlings were produced in either case, but enough evidence is not to hand to determine germination percentage.

Hybrid 11648

Towards the end of October seven of the original ten Hybrids 11648 started to pole. This was unexpected as it is a most unusual occurrence in Tanganyika, where this Hybrid had only once been known to pole. It usually comes to a stage when production of long leaf ceases and all further leaves rapidly become shorter and shorter. The plant is then of no value and is cut out. The leaf count of the seven plants which have poled varied from 293 to 358 and the average number of leaves and their length are shown in Table VII.

Table VII—Leaf Production of Hybrid 11648

Leaves over 3′ long	137
Leaves between 2′ 6″ and 3′ long	45
Leaves between 2′ and 2′ 6″ long	53
Total commercial leaves	235
Leaves dried up and less than 2′	86
Total number of leaves produced	321

This average of 321 leaves is considerably less than expected from the performance of the plant in Tanganyika. However, these figures are favourable when compared to sisal, but of course are based on an insufficient number of recorded plants to provide conclusive evidence.

Hybrid Rhizome Propagation

Raised beds were constructed 50 in. × 80 in., filled with a mixture of soil and sisal waste and then given a top dressing of about 3 in. of well rotted compost soil. Each bed contains 200 sections cut from rhizomes of Hybrid 11648 planted 4 in. × 5 in. The beds are very well drained, a factor which has been found to

be essential when propagating from rhizomes. Trouble has been experienced with fungus attack in rhizome propagation, so a number of beds have been treated with fungicides, which have also been put on to the rhizomes before planting. These treatments have not eliminated all losses, but have considerably reduced them. Other treatments with insecticides, hormone powder and herbicides and various fertilizers have been tested, but insufficient information has come in to comment on.

There are over 6,000 pieces of rhizomes planted and many of them are developing into plants.

Hybrid Variety Trials

Trial Comparing Eight Hybrids to Sisal, Planted: April, 1952

The average production from the Hybrids and the sisal in this trial is summarized below:—

	Leaf Count October, 1961	No. of Leaves Cut per Plant May, 1961	Tons Fibre per Acre May, 1961	Leaves x 1,000 per Ton Fibre May, 1961	Poling Per cent October, 1961
					%
Common Sisal	258	152	6·53	46·4	59
1155	334	146	3·75	81·5	1
1269	336	156	4·53	68·9	90
1300	318	138	3·75	75·1	1
1317	433	216	4·15	104·5	0
1475	340	146	6·23	49·4	15
1660	337	203	5·80	70·3	87
6964	360	223	5·15	86·6	94
7131	323	149	2·90	101·3	99

Although none of these Hybrids have yet shown themselves to be superior to sisal, some are developing in an interesting manner and will warrant further work.

Grass and Legumes

The administration of the Pasture Research Substation, Thika, came under the Sisal Research Station early in 1961, and most of the work on grasses and legumes was transferred to that Station. The collections of various grasses and legumes were expanded and seed production started on promising species and in spite of the drought during the early part of the year, demonstration areas have been well established.

K. LERCHE,
Agricultural Officer.

ANNUAL REPORT OF THE OFFICER-IN-CHARGE IRRIGATION INVESTIGATIONS

Irrigation Research Station, Mwea/Tebere, Embu

Weather Conditions

The total rainfall for the year was 53.53 inches, the highest figure in seven years of recording. The exceptionally heavy rainfall in October and November caused damage to many of the short rains crops planted on the rice scheme.

Rainfall was as follows:—

Month	Inches	Days
January	0·62	3
February	Nil	Nil
March	3·70	6
April	7·38	13
May	1·95	10
June	2·35	5
July	0·29	4
August	Nil	Nil
September	1·27	5
October	13·12	17
November	22·78	25
December	0·07	1
Total	53·53	89

Rainfall intensity, air temperature, evaporation and sunshine records were kept throughout the year.

Report on Experiments

1. *Times-of-Application of Nitrogen Trial*

This trial was started in the long rains of 1960 and was completed after the long rains crop in 1961. The object was to test the effects of various times of application of nitrogen, in the form of sulphate of ammonia, on the yield of paddy. The design was a 5 × 5 Latin square, and the treatments were as follows:—

(*a*) Control.

(*b*) 1 cwt./acre before planting.

(*c*) 1 cwt./acre 3 weeks after planting.

(*d*) 1 cwt./acre 9 weeks after planting.

(*e*) 1 cwt./acre at flowering time.

The results for 1961 crop are given in Table 1. They show no significant differences between treatments.

Table I—Yield of Grain in Lb. per Acre

	Treatments				
	A	B	C	D	E
Yield	3,061	3,128	3,164	2,977	3,176

S.E. = ±162 lb./acre.

2. *Rice Nursery Manurial and Spacing Trial*

This trial was started in the short rains of 1960 and is still in progress. The object of the trial is to compare the growth of seedlings in the nursery planted at three different seeding rates, and with two levels of nitrogen and two levels of phosphate. The design is a 3 × 2 × 2 factorial.

The treatments were as follows: 1 lb. of seed per 30 sq. ft. (S1), 1 lb. per 70 sq. ft. (S2), and 1 lb. per 110 sq. ft. (S3). Nitrogen treatments comprised nil (No) and 5 cwt. per acre of sulphate of ammonia (N1) and phosphate treatments similarly comprised Nil (Po) and 5 cwt. per acre of double superphosphate (P1). The results obtained from the 1961 long rains crop are presented in Table II.

TABLE II—YIELD OF GRAIN IN LB. PER ACRE

	Seed Rates			
	S1	S2	S3	L.S.D. 5%
Yields	3,375	3,562	3,424	241
Nitrogen	No	Nl		
Yields	3,147	3,760		339
Phosphate ..	Po	Pl		
Yields	3,458	3,450		339

It can be seen that 5 cwt. per acre of sulphate of ammonia applied in the nursery resulted in a 613 lb. per acre increase in yield (L.S.D. 5 per cent = 339 lb.). The application of superphosphate did not improve yields, and seed rate in the nursery did not result in significant differences either.

3. *Rice Fertilizer Trial*

This trial has been in progress since the long rains, 1958, the treatments being modified in 1959 to include application of straw and FYM. The object of the trial is to test the effect of three rates of application of double superphosphate and sulphate of ammonia and the application of FYM_3 and rice straw on the yield of paddy. The design is a three factorial.

The treatments were as follows: No nitrogen (No), 1 cwt. per acre sulphate of ammonia (N1) and 2 cwt. per acre sulphate of ammonia (N2). No phosphate (Po), 1 cwt. per acre of double superphosphate (P1), and 2 cwt. per acre of double superphosphate (P2). Nil (0), straw from previous crop ploughed in (S), and 2½ tons per acre FYM (M). The results for the 1961 long rains crop are summarized in Table III.

TABLE III—YIELD OF GRAIN IN LB. PER ACRE

No	3,325	Po	3,160	O	2,995
N1	3,319	P1	3,356	S	3,362
N2	3,183	P2	3,310	M	3,469

L.S.D. (P ± 0·05) = 332 lb.

Straw increased the yield by 367 lb. per acre and FYM by 474 lb. per acre both responses being significant. Nitrogen and phosphate were without significant effects.

4. *Rice Variety and Spacing Trial*

This trial was started in the long rains to compare five selected varieties against the standard variety Sindano. Two spacing treatments of 4 in. × 4 in. and 9 in. × 9 in. were incorporated. No significant differences occurred between the spacings or the varieties which comprised Sindano, Faya S.L., Gamti, Radin Goi, S.C.70, and Basmati. The trial is to be repeated in 1962.

5. *Potash Fertilizer and Spacing Trial*

This trial was started in the long rains, 1960, to compare the effects of three different spacings and two different rates of application of muriate of potash on the yield of paddy. The design was a 6 × 6 Latin Square. The treatments comprised spacings at 3 in. × 3 in. (S1), 6 in. × 6 in. (S2) and 9 in. × 9 in. (S3) and potash at Nil (Ko) and 1 cwt. per acre of muriate of potash (K1). The results for the 1961 crop are presented in Table IV.

TABLE IV—YIELDS OF GRAIN IN LB PER ACRE

S1	3,142	Ko	3,081
S2	3,409	K1	3,596
S3	3,194		
L.S.D. 5% ..	353 lb.	L.S.D. 5% ..	288 lb.

The application of potash increased the yield by 515 lb. per acre, a highly significant increase. Spacing treatments did not produce significant effects.

6. *Sugar Cane Variety Trial*

The sugar cane variety trial was cut at the commencement of the 1961 long rains. This trial is on the red soils of the station. The yields are summarized in Table V.

TABLE V—YIELDS OF CANE IN TONS PER ACRE

Variety	*Yields*
Co 421	67·2
Co 331	67·0
Co 419	57·9
NCo 310	50·6
B. 37913	47·7
B. 41227	45·3
Co 408	28·5
P.O.J. 2961	20·1

	Tons/Acre		
	0·05	0·01	0·001
L.S.D.	P = 8·6	11·6	13·3

Variety Co 421 outyielded all other varieties except for Co 331. It appears that Co 421, Co 331, Co 419 and NCo 310 are the most promising varieties under Mwea conditions.

T. M. WRIGHT,
Assistant Agricultural Officer (Irr. Res.).

Galole

Report on Experiments

1. *Cotton Time-of-Planting Trial*

The variety UK.51 was planted on four successive dates. The results indicate that, even with irrigation, planting at the onset of the long rains in early April has a distinct advantage over planting in late April or early May. The results are summarized in Table VI.

Table VI—Yield of Seed Cotton in Lb. per Acre

	Date			
	4th April	11th April	25th April	9th May
Yield	1,731·2	1,564·6	1,415·3	926·0

L.S.D. 0·05 198·4
0·01 274·4

2. *Groundnut Spacing Trial*

The variety Natal Common was grown at three different spacings, in a randomized block with nine replications. The large number of replicates was necessary due to the very patchy fertility of the irrigated soils at Galole. The results are given in Table VII.

Table VII—Mean Yields Unshelled Nuts in Lb. per Acre

	Spacing		
	1′ x 2′	1½′ x 2′	2′ x 2′
Yield ..	1,117·0	1,053·6	962·1

L.S.D. (P = 0·05) 195·9

Yield differences do not reach significance at the 5 per cent level.

3. *Groundnut Variety Trial*

In 1960, 75 varieties, selections from Kibos, were grown in observation plots. From these, four were selected for vigour disease resistance and pod size. In 1961, these were included in a variety trial with Natal Common. The design was a randomized block, with nine replications. The results are summarized in Table VIII.

Table VIII—Mean Yields Unshelled Nuts—Lb./Acre

	Variety				
	83	3	Natal Common	58	67
Yield ..	1,703·7	895·8	751·5	1,117·4	607·2

L.S.D. (P = 0·05) 665·4
(P = 0·01) 968·1

Variety 83 significantly outyields all other varieties except 58 ($P = 0.05$). There is no significant difference between these two varieties. Natal Common matured three weeks earlier than the other varieties, and because of its upright habit, was easier to harvest than the other varieties which are either semi-erect or spreading.

R. C. GRIMES,
Agricultural Officer (Research).

Perkerra Experimental Station

1. Onion Experiments

A trial was conducted in co-operation with E.A.A.F.R.O. to determine what frequency of watering is required to produce satisfactory yields of onions. There were three treatments which comprised watering every five days, every ten days and every 15 days; the total amount of water applied was approximately the same for each treatment. The 5-day watering interval proved to be best, the yields on this treatment being 7.15 tons per acre, compared with 4.18 tons per acre on the other treatments. The 5-day treatment produced 71 per cent Grade A onions, whilst the 10-day and 15-day watering treatments produced only 53 per cent and 46 per cent Grade A onions respectively.

Sets versus seedlings, at two different spacings, were compared in five replicates of a randomized block design. Sets planted at a spacing of 15 in. × 3 in. outyielded seedlings at the same spacing by 3.65 tons per acre. Sets planted at 15 in. × 4 in. outyielded seedlings at that spacing by 4.04 tons per acre. There were no significant differences between the spacing treatments for either sets or seedlings.

The remainder of the onion trials were seriously affected by the disease "blast" probably because of the exceptionally wet short rains season; it reduced the yields by at least half, and the results are therefore not presented.

2. Beans

The bean variety Richmond Wonder and Canadian Wonder were compared in a randomized block design each at two spacings of 18 in. × 8 in. and 18 in. × 12 in. Richmond Wonder at the narrower spacing yielded 1,245 lb. per acre, 373 lb. per acre more than at the wider spacing. Richmond Wonder outyielded Canadian Wonder at both spacings.

M. F. WATSON,
Agricultural Research Officer.

Ahero Irrigation Station

Water Usage Trial on Irrigated Cotton

Three irrigation régimes were combined with three planting dates; but, as the last planting date was expected to be at the break of the long rains, the high

and low water régimes combined with this planting date were replaced by a single "no irrigation" treatment. The combinations were randomized within four blocks and the treatment combinations were as follows:—

Treatment	Plant Date	Minimum Soil Moisture Per cent Allowed at 18"
A	January 15	31·4
B	,,	28·6
C	,,	25·8
D	February 15	31·4
E	,,	28·6
F	,,	25·8
G	March 15	No irrigation
H	,,	28·6

The moisture percentages were selected on the basis of the amount of available water remaining in the soil at the 18 inches depth. The percentages corresponded approximately to 75, 50 and 25 per cent of available water remaining. A summary of the yield results and water applied is given in the following table:—

Treatment	Yield	Irrigation Water Applied	Rain	Total Water Applied
	lb./acre	*Inches*	*Inches*	*Inches*
A	1,104	26·3	17·6	43·9
B	1,272	18·9	17·6	36·5
C	1,296	14·0	17·6	31·6
D	1,270	31·1	17·0	47·1
E	1,108	14·7	17·0	31·7
F	970	7·8	17·0	24·7
G	567	Nil	16·5	16·5
H	453	7·7	16·5	24·2

The March planting date was significantly worse than the January or the February planting dates which were not themselves significantly different. No significant difference was observed between irrigation treatments indicating that the lowest level was adequate. It follows from the results that F might be the most economically sound treatment, since it produced a yield not significantly different from the highest irrigation treatment and yet used the least amount of irrigation water. The variety S47, which was used, is not an irrigation variety, so these results can only be taken as an indication. The future programme will be carried out on irrigation varieties.

C. C. H. HILL,
Provincial Research Officer.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), CENTRAL PROVINCE

Rainfall at Experimental Stations, 1961

	Embu		Molinduko	
	Inches	*Days*	*Inches*	*Days*
January	0·23	3	0·34	2
February	1·02	5	0·15	3
March	2·70	5	1·87	6
April	11·38	15	11·49	14
May	9·43	14	3·35	8
June	1·25	10	0·59	3
July	1·11	10	0·52	2
August	1·09	18	0·61	8
September	2·40	12	1·80	8
October	26·37	23	19·97	21
November	25·03	24	27·46	26
December	2·18	9	2·75	8
Total	84·19		70·90	
1960	30·83		25·59	
1959	40·33		34·50	

The exceptionally heavy rainfall in October and November caused some erosion on parts of both Stations, and some damage to the short rains crops, especially beans. The rainfall during these two months far exceeded the annual total for 1959, and was nearly three times the 1960 total!

Reports on Experiments

STAR GRASS AND LOWER KIKUYU GRASS ZONE, EMBU FARM

(4,800 *ft. and* 42 *in. average rainfall*)

Farmyard Manure, Phosphate and Nitrogen Rates Trial

This 3^3 trial, reported last year, was again planted with maize to test the residual effect of double superphosphate applied in 1959 at 1 cwt. (P1) and 2 cwt. (P2) per acre; and farmyard manure at 4 tons (FYM 1) and 12 tons (FYM 2) per acre respectively. Ammonium sulphate has been reapplied annually to each crop at 1 cwt. (N1) and 2 cwt. (N2) per acre.

The mean yields, in lb. per acre of maize grain were:—

Treatment	With	Without	Response
N1 (reapplied) ..	4,053	3,678	+375
N2 (reapplied) ..	3,694		+16
P1 (residual)	3,865	3,400	+465
P2 (residual)	4,159		+759
FYM 1 (residual) ..	3,633	3,896	−263
FYM 2 (residual) ..	3,896		0

Mean yield of control plot = 3,277 lb./acre.
Mean yield of trial = 3,808 lb./acre. C. of V. = 14·6%
Significant responses, P. at 0·05 = 383 lb. acre.
P. at 0·01 = 521 lb./acre.

As in the previous year the residuals from both levels of the 1959 phosphate dressing significantly increased the yield of maize. The responses illustrate the great economic advantage of using phosphate for potatoes and maize on these soils. In this experiment, double superphosphate, applied in 1959, has given the following yield increases in the three subsequent long rains crops.

YIELD INCREASES PER ACRE OVER THE CONTROL

1 Cwt. Supers Applied, 1959	Value	2 Cwt. Supers Applied, 1959	Value
	Sh. cts.		*Sh. cts.*
1959 English potatoes = 6 bags (180 lb.)	120 00	English potatoes = 5·4 bags (180 lb.)	108 00
1960 maize = 241 lb. ..	32 41	maize = 151 lb.	20 31
1961 maize = 465 lb. ..	62 54	maize = 759 lb.	102 09
Gross Profit ..	214 95	Gross Profit	230 40
Less cost of fertilizer ..	37 58	Less cost of fertilizer ..	75 15
Net Profit	177 37	Net Profit	155 25

In estimating these profits, a bag of potatoes has been valued at Sh. 20; maize at 13.45 cts./lb., and the cost of the fertilizer at Sh. 37.58/cwt.

The F.Y.M. residuals gave no crop increase, and this bears out previously observed results, that manure is generally only effective for about two seasons after its application.

The yield increases from the N1 dressing just fails to reach significance. This result also confirms earlier evidence that the response to nitrogen is erratic and the use of this fertilizer cannot therefore safely be recommended, especially if the crop is to be "dry planted" and can take full advantage of the accumulated reserves of nitrogen already in the soil.

Farmyard Manure and Nitrogen Trial

This 4 × 4 factorial experiment was planted with maize to test the residual effect of farmyard manure applied in 1959 at 4 tons (FYM 1); 8 tons (FYM 2); and 12 tons (FYM 3) per acre. Ammonium sulphate has been applied annually since 1959 at the rates of 1 cwt. (N1); 2 cwt. (N2); and 3 cwt. (N3) per acre. The crop was top-dressed with the N when about 18 in. high. The mean yields, in lb. of maize grain per acre were:—

Treatment	With	Without	Response
N1 (reapplied) ..	3,577	3,336	+241
N2 (reapplied) ..	3,756		+420
N3 (reapplied) ..	3,146		−190
FYM 1 (residual) ..	3,192	3,674	−482
FYM 2 (residual) ..	3,597		−77
FYM 3 (residual) ..	3,350		−324

Mean yield of control plot = 3,028 lb./acre.
Mean yield of trial = 3,454 lb./acre. C. of V. = 10·6%
The main effects failed to reach "F" test significance.

These results therefore support the previous comments concerning lack of persistence in the influence of F.Y.M. residuals and the unreliability of responses to fertilizer nitrogen on maize.

Comparison of Tanganyika Rock Phosphate (Minjingu Rock) with Double Superphosphate

Muratha maize was planted in a randomized block experiment to test the residual effect of Minjingu rock phosphate and double superphosphate, both of which has been applied to a potato crop in the previous year. The results are tabulated below.

Treatment	1960 Potatoes Mean bags/acre	1961 Maize Mean bags/acre
(per acre)	*(fertilizer applied)*	*(residual effects)*
Control	47·1	25·4
168 lb. Minjingu	51·4	25·1
150 lb. double supers ..	49·1	26·4
336 lb. Minjingu	50·6	26·5
210 lb. double supers ..	50·1	27·2
672 lb. Minjingu	47·3	26·7
420 lb. double supers ..	50·8	27·6
S.E. of a mean	4·6	3·1
C. of V.%	6·3	9·4

Due possibly to a substantial basal dressing of farmyard manure on the site of the experiment prior to starting in 1960, there have been no significant differences between any of the treatments in either year. The results are inconclusive.

COFFEE TRIALS

Picking continued on the coffee variety trial (planted in 1951) from May to December. The yields were:—

Variety	*Clean Coffee (cwt./acre)*
SL. 28	7·2
SL. 34	6·6
N 197	5·6
SL. 14	4·9
KENTS	4·7
Mean	5·8
Least significant differences	P at 0·05 = 2·10 cwt./acre.
	P at 0·01 = 2·93 cwt./acre.

The variance ratio showed no significance between variety yields although the "t" test shows the yield of SL 28 to be significantly greater than that of Kents.

No coffee was picked from the mulch and anti-leaf fall spray trial during 1961 due to a change of cycle.

Grass Woodland Zone: Molinduko Farm

(4,200 ft. and 32 in. average rainfall)

A 3^3 factorial experiment, started in 1960, was planted with maize during the long rains of 1961. The treatments were reapplied, viz., ammonium sulphate at 1½ cwt. (N1), and 3 cwt. per acre (N2): double superphosphate at 1½ cwt. (P1), and 3 cwt. per acre (P2): farmyard manure at 11 tons (FYM 1) and 22 tons per acre (FYM 2). The mean yields in lb. of maize grain per acre were:—

Treatment	With	Without	Response
N1	3,120	2,906	+214
N2	2,977		+71
P1	3,055	2,229	+826
P2	3,718		+1,489
FYM 1	3,340	1,816	+1,524
FYM 2	3,846		+2,030

Mean yield of control plot = 1,026 lb./acre.
Mean yield of trial = 3,001 lb./acre C. of V. = 18·3%
Significant responses. P at 0·05 = 552 lb./acre.
P at 0·01 = 764 lb./acre.
P at 0·001 = 1,220 lb./acre.

The application of farmyard manure resulted in a highly significant yield increase. There was also a marked linear response to double superphosphate, the 3 cwt. dressing giving more than the 1½ cwt. dressing. The application of nitrogen caused no significant yield increase and, apart from this, the results accord with those obtained from the previous season's potato crop in this experiment.

In addition to this fertilizer trial, observations have continued on a number of cash, food, and fodder crops. Twelve varieties of groundnuts, which were being bulked for more precise comparison, were attacked by a disease of uncertain cause, known to the pathologists as "Pseudo Wilt". However, in view of the encouraging results obtained earlier it is intended to continue with groundnut observations in the hope that some means may be found of controlling this disease.

Results obtained from a comparison on kidney bean varieties in a non-statistical trial during the short rains are:—

Variety	*Yield (bags/acre)*
Herbert Sproggett	5½
Canadian Wonder	3
Boston beans	3
Richmond Wonder	3
Michigan pea bean	2½

So far Herbert Sproggett has usually given the highest yield, but it is said to be less palatable than the others.

Taboran maize is being multiplied for issue in the Province as a suitable variety for planting during the short rains.

Preliminary trials of grasses and forage crops continue. Sudan grass and Columbus grass, planted on a field scale gave yields of six tons per acre and eight tons per acre of fresh material. A trial in which the yield of Napier grass was compared at row spacings of 4 ft.; 8 ft.; and 12 ft. has been discontinued as it was found, in common with similar trials elsewhere, that yields were higher from the wider spacings than from the closer spacings.

Observation plots of ley grasses show that Rhodes grass, especially the Mbarara and Endebess varieties, makes excellent growth under these conditions and could confidently be recommended for short term leys of two-three years.

R. STRANGE,
Agricultural Officer (Expts.).

ANNUAL REPORT OF THE AGRICULTURAL RESEARCH OFFICER, RIFT VALLEY PROVINCE

Rainfall

TABLE I—MONTHLY RAINFALL IN INCHES ON EXPERIMENTAL STATIONS

	Kitale	Eldoret	Ol Joro Orok	Nakuru	South Kinangop	Perkerra
Jan. ..	0·12	0·05	0·22	0·29	0·55	0·24
Feb. ..	1·24	0·35	0·13	0·00	2·80	0·43
March ..	0·71	0·83	1·30	2·04	2·86	1·36
April ..	4·49	4·42	3·41	4·30	6·98	1·36
May ..	3·74	3·55	2·37	1·89	5·72	1·25
June ..	5·33	3·52	2·21	1·86	2·68	1·25
July ..	8·70	4·76	4·74	2·90	2·98	1·54
Aug. ..	7·73	10·56	9·81	5·41	3·32	3·91
Sept. ..	5·68	1·98	4·38	2·64	3·82	0·90
Oct. ..	9·44	2·69	8·81	4·12	10·78	3·66
Nov. ..	14·27	8·95	15·14	12·98	14·80	11·87
Dec. ..	5·27	4·67	10·35	3·00	6·20	5·48
TOTAL ..	66·72	46·34	62·87	41·43	63·49	33·25

All stations except Kitale, and to a lesser extent Eldoret, suffered badly from the intense drought during the first half of the year, and several experiments had to be abandoned or postponed at Ol Joro Orok and in Nakuru District. The drought was followed by good rains culminating in exceptionally wet conditions which ruined a number of established experiments and seriously delayed harvesting others.

Kitale Experimental Station (6,200 ft.)

MAIZE EXPERIMENTS

Five different populations, ranging from 8,000 plants per acre to 16,000 plants per acre, were compared in a randomized block design. Yields were highest at 10,000 to 14,000 plants per acre. The number of blind plants increased as the population increased and the average weight of cobs per plant declined.

Fertilizer investigations continued on three of the main soil types in the area. On the Endebess red sandy loam soils, in the presence of phosphate, top-dressing at knee height with 100 lb. of sulphate of ammonia increased the yield by 3.3 bags per acre and a 200 lb. top-dressing increased the yield by five bags per acre. Only slight differences in yield were obtained between dressings of double superphosphate applied at 50 lb., 75 lb. and 100 lb. per acre at planting. Populations of 12,000 plants per acre gave the highest yields.

Three levels each of superphosphate and sulphate of ammonia and three plant populations were compared in a 3^3 factorial design on the Black Elgon loam soils. There was a strong linear response to sulphate of ammonia top-dressings. An increase of 8.7 bags per acre was obtained at the 200 lb. level. There were no significant responses to phosphate. Again a population of 12,000 plants per acre gave the highest yield. In a similar trial on ridged and furrowed vlei soils, top-dressings of sulphate of ammonia again had a marked linear effect. An increase in yield of 5.4 bags per acre was obtained with a 150 lb. dressing. There were only slight responses to 50 lb. per acre and 100 lb. per acre of double superphosphate on this soil.

The effect of splitting applications of 200 lb. per acre of sulphate of ammonia was investigated in a randomized block design. It was found that three 66 lb. dressings applied to maize at 2 ft. high, 4 ft. high and 6 ft. high gave no increase in yield over either two 100 lb. applications at 2 ft. high and 4 ft. high or a single application of 200 lb. given at the 2 ft. stage.

Four nitrogenous fertilizers comprising ammonium sulphate nitrate, sulphate of ammonia, calcium ammonium nitrate and urea were compared in a randomized block design. All were applied at the knee-height stage at a rate equivalent to 200 lb. of sulphate of ammonia. There were no significant differences between these fertilizers which outyielded control by a mean of 6.5 bags per acre.

There were good residual responses to double superphosphate, Japanese fused magnesium phosphate and Tanganyika rock phosphate in a trial which commenced in 1960. The object was to compare six phosphate fertilizers all applied at a rate equivalent to 100 lb. of double superphosphate. This year's crop was maize.

Alternative Crops

Four spacings of California Grey Stripe and Giant White sunflowers were compared in a randomized block design. Spacings of 42 in. by 12 in., 42 in. by 16 in., 42 in. by 20 in. and 42 in. by 24 in. showed no differences in yields. The variety California Grey Stripe gave a mean yield of 6.9 bags (100 lb.) per acre and Giant White yielded 14.6 bags per acre. In a fertilizer trial with the variety Giant White applications of Nil, 50 lb., 100 lb. and 150 lb. of double superphosphate per acre had no influence on yields. The mean yield for this trial was 12.3 bags per acre.

In a fertilizer trial on soya beans, 50 lb. per acre of double superphosphate raised the yield from 3.3 bags (200 lb.) per acre to 4.3 bags per acre. Higher applications of 100 lb. and 150 lb. of double superphosphate gave no further increase in yield. Six spacings for soya beans were compared using the varieties Blyvoor and Vorster. There were no significant differences in yield. The spacings were 21 in. by 3 in., 21 in. by 6 in., 21 in. by 9 in., 14 in. by 6 in., 14 in. by 9 in. and 14 in. by 12 in.

Fodder Crops

In a fertilizer trial 100 lb. per acre of double superphosphate increased the yield of fodder beet from 9.7 to 14 tons per acre and the yield of mangolds from 11.4 to 15.6 tons. An application of 200 lb. of double superphosphate increased the fodder beet yield by a further 1.5 tons per acre but gave no further increase in the yield of mangolds.

Pig Feeding

Two trials involving rations with a high percentage of maize were completed. It was found that although pigs fed on maize meal and skim milk had equally good conversion ratios and liveweight gains as those fed on barley meal and skim milk, the carcasses were far inferior in quality, receiving low gradings at the factory. The quality of the carcasses produced from a ration of maize and a commercial concentrate (P.I.B.) were even more inferior; so also were the rates of conversion and liveweight gain. Slightly better gradings were obtained when this ration was restricted. Maize meal with the P.I.B. concentrate was highly unpalatable and unsuitable for small weaners. However, a ration of barley meal and this concentrate appeared to be quite suitable in this respect.

Calf Rearing

Three levels of feeding whole milk and skim milk to calves were compared. The treatments were as follows—

(*a*) a total of 20 gallons of whole milk and 120 gallons of skim milk fed up to the time of weaning;

(*b*) 40 gallons of whole milk and 100 gallons of skim; and

(*c*) 60 gallons of whole milk and 80 gallons of skim.

The growth rates were slightly reduced as the amount of whole milk fed was decreased. It was concluded that the reduced whole milk feeding could not be recommended to farmers who sell their milk on a butterfat market because of the small saving thus achieved.

Cow Feeding

The effects of "steaming up" with concentrates for six weeks before calving and of feeding to production for six weeks after calving were investigated using the station herd of Jersey milking cows. The control group received neither of these treatments. There were no differences between the subsequent total lactation yields of the cows. However, the cows fed to production during the six-week period after calving produced slightly more milk during this particular period. It was concluded that the condition of the cows prior to calving was sufficient to maintain the subsequent yields and "steaming up" was not therefore necessary or beneficial in this instance.

Eldoret Experimental Station (7,000 ft.)

Farmyard Manure

A trial to determine the effect of the time application of manure was repeated for the second year. It showed that applications of manure made close to the planting date were more beneficial than those made earlier and that ploughing the manure in was more efficient than top-dressing. Increased yields of up to six bags of maize per acre were recorded. The manure was applied at the rate of 8.6 tons per acre.

Pig Feeding

Work on heavy hog production continued. Twenty-four large white weaners were divided into three groups, and each group was fed one of the following rations:—

X—A mixed maize, barley and meat and blood meal ration, fed on a restricted scale.

Y—A mixed maize and barley meal ration with skim milk, fed *ad lib*.

Z—A maize ration with skim milk, fed *ad lib*.

Weight gains up to 140 lb. liveweight were satisfactory on all three rations. The mixed maize and barley ration with skim milk gave the fastest rate of gain.

At 140 lb. liveweight the meat and blood meal was omitted from treatment X and skim milk was omitted from treatments Y and Z. The weight gains of the hogs on treatment Z immediately fell behind those on X and Y. Considerable difficulty was experienced in getting these hogs on treatment Z to slaughter weight.

Calf Rearing

Twenty-one Red Poll calves were divided into three groups, each group being weaned according to one of the following three treatments: —

A—Conventional whole milk.

B—Early weaning pencils (Unga).

C—Early weaning pencils (Unga) plus 5 per cent tallow.

The conventionally weaned calves received 56.25 gallons of whole milk over a period of 85 days and each consumed an average of 59.64 lb. of a 50 per cent oats and 50 per cent maize meal mixture. The calves on treatments B and C were each fed 17.75 gallons of whole milk in the first 21 days and then were changed completely to early weaning pencils. The calves in group B consumed an average of 173.75 lb. each up to 85 days old and in group C calves consumed an average of 179.25 lb. each. The liveweight gains of groups B and C were slightly better than those of group A, mainly due to a number of cases of white scour which occurred on the whole milk treatment. Liveweight losses, when the calves were turned out to pasture, were slightly less in group C, which had been receiving tallow with the pencils, than group B. It was concluded that it is cheaper to wean calves early and sell the whole milk or cream than to rear calves entirely on whole milk and cereals.

Ol Joro Orok Experimental Station (7,800 ft.)

Ley and Fodder Species

Six varieties of *Paspalum* planted during May failed, confirming the findings of the 1960 trial with the same varieties. They appear to be unsuited to the environment at Ol Joro Orok. Good green matter yields of various species of fodder sorghums were obtained. Columbus grass was the most productive, and yielded 31.8 tons of green material per acre in two cuts taken in December and January. Velvet sorghum and Sudan grass gave yields of 23.2 tons and 19.6 tons of green matter respectively, and white sweet sorghum produced 10.5 tons of green material per acre. The most productive of six selections of *Setaria splendida,* planted in 1960, proved to be K51128 which yielded 25.4 tons of green material per acre in two cuts taken in July and at the end of December. *Brachiaria ruziziensis* yielded 31.9 tons of green matter per acre and was found to be quite palatable for sheep. This species, however, did not perform well on the waterlogged vlei soils.

The four varieties of Subterranean Clover, Clare, Dwalganup, Mount Barker and Yarloop, sown in 1960, were observed for their capacity for regrowth. The Clare variety was outstanding in this respect, regeneration over the plot amounting to 75 per cent. The ability of the remaining varieties to regenerate was limited and the plots were invaded by indigenous clovers. The second-year growth of the other clovers under test has been variable. *Trifolium pratensis* (N.Z. Broad Red) made very good growth after the rains and is yielding greater bulk than any other variety. *T. burchellianum* var. Johnstonii and *T. pratensis* var. Montgomery have persisted but growth has been poor. *T. incarnatum* died out completely.

No differences were observed between drilling and broadcasting in an establishment trial using a seeds mixture of 15 lb. of S.24 ryegrass seed and 2 lb. per acre of Clare subterranean clover. Growth was very good but the seeding rate of S.24 ryegrass was too high for the clover which began to disappear early in the season.

Only small differences in yield were observed between the two varieties of lucerne, Alta Sierra and Saladina, which yielded 14.6 and 13.7 tons of green material respectively. These yields were obtained between 1960 and the end of 1961.

On the vlei soils *Phalaris* has proved to be one of the best grasses under test, yielding 9.7 tons of green matter in the first six months of growth. The Mbarara and Endebess varieties of Rhodes grass failed to establish a reasonable stand on the vlei. A seeds mixture of 10 lb. Italian ryegrass, 10 lb. Westerwolths ryegrass and 4 lb. Louisiana clover produced 11.9 tons of green material per acre on the vlei. The high seeding rates used for the grasses excluded the clover from the sward. A mixture of Nandi setaria, S.24 ryegrass, *Phalaris tuberosa* and Ruepells clover sown at seeding rates of 26 lb., 11 lb., 10 lb. and 1 lb. per acre respectively produced a wholly ryegrass stand which yielded 14 tons of green material to the acre.

Fertility Building on Vlei Soil

A wide variety of green crops, grasses and legumes were grown successfully on a ridged-and-furrowed vlei. It was intended to plough in half of each crop and graze the other half with the object of comparing these treatments as a means of improving the fertility of heavy waterlogged land. However, at the time of optimum growth both for ploughing in and grazing it was impossible to do either because of the condition of the land. It appears unlikely that either of these methods could be used as a practical routine. The most effective method of improving this land is the use of tile drains in the furrows. These remove surface water very effectively and permit the land to be worked when untiled land is unworkable.

Pig Feeding

The final results of the pig-feeding trial reported in part in 1960 are now available. In this trial comparisons were made between four levels of feeding a mixed cereal and commercial supplement (Pig Industry Board) ration, a mixed cereal and meat-meal ration, and a barley and skim milk ration. Restricted feeding did not affect the growth rate or carcass quality, but it reduced food consumption and gave better conversion ratios as the level of restriction was increased. The ration with meat meal was unsuitable for pigs below 40 lb. liveweight; the skim milk and barley ration was far superior to the others up to 100 lb. liveweight. The pigs fed on skim milk and barley killed out better, had a better quality fat and produced more streak in the bacon than the others.

Sheep Experiments

The milk yields of 20 Corriedale ewes were determined over a 10-week period using a lamb suckling technique. The average yield of milk over this period was found to be 209.4 lb., the lowest yield recorded being 172.9 lb. and the highest 270.9 lb. There appeared to be no correlation between the milk yield and the liveweight gain of the lambs or between the birthweight of the lamb and the milk yield.

Observations of the effects of flushing Corriedale ewes before tupping, and steaming up before lambing, made during 1960 and 1961, indicated that these practices increase the lambing percentage and also reduce the number of lambs lost during the first few days of life.

In a trial to determine the effects of feeding crushed oats to lambs on pasture, 52 crossbred lambs were divided into two matched groups. One was fed crushed oats *ad libitum* as a creep feed concentrate. The concentrate increased liveweight gains up to 50 lb.; thereafter no advantage was noticeable although greater quantities of oats were consumed. Feeding oats to the time of slaughter did not improve carcass gradings, reduce time to slaughter or improve killing-out percentages. It was concluded that no economic advantage was gained by feeding oats.

A comparison was made of Corriedale × Border Leicester, Corriedale × Dorset Horn and Corriedale × Hampshire Down lambs in order to determine the suitability of these crosses for fat lamb production. Only the Hampshire Down cross shows promise because of its faster liveweight gains and earlier finishing. The conformation and growth characteristics of the other crosses were such that poor carcass gradings resulted even when they were killed at a greater liveweight than the Hampshire Down crosses.

Nakuru District

Potatoes

Due to the weather the only trial successfully completed in Nakuru District was a fertilizer trial on potatoes at Mau Narok. Applications of double superphosphate at 0, 3 and 6 cwt. per acre and sulphate of ammonia at 0, 1½ and 3 cwt. per acre were compared in a 3^2 factorial design, using the variety Maritta. There were good responses to phosphate, the mean increase in yield amounting to 58 bags per acre from the 3 cwt. application and to 82 bags per acre from the 6 cwt. application. Sulphate of ammonia was effective only in the presence of phosphate, giving a mean increase in yield of 30 bags per acre from the 1½ cwt. per acre application and 47 bags per acre with the 3 cwt. application.

The combined application of 6 cwt. of superphosphate and 3 cwt. of sulphate of ammonia increased the mean yield from 112 bags an acre to 215 bags per acre.

Acknowledgements

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ANNUAL REPORT OF THE AGRICULTURAL RESEARCH OFFICER, NORTHERN DIVISION, NYANZA PROVINCE

Weather

The monthly totals for all Experimental Stations are given in the appendix. The rainfall pattern of all areas has been atypical. The long rains were not particularly heavy or marked, and by August most stations reported totals below average for the first eight months of the year. November was extremely wet in all districts, and this combined with the fact that rains were exceptionally heavy for September, October and December produced rainfall totals well above the average for the year.

Reports on Experiments

Fertilizer Trials (Colony Programme)

Fifteen exploratory trials were planted, of which nine were harvested; these trials gave further useful indications to fertilizer requirements. The failures were with one exception in Central Nyanza, where Army worms and drought at the beginning of the year made any cropping difficult. Results from the trials in North and Elgon Nyanza have resulted in revised recommendations for most of the major soil types.

All five fertilizer rates trials were brought to a successful harvest and gave useful results, which have been covered in the Senior Soil Chemist's report.

The 3³N.P.M. rates trial on Red Basaltic loam at Kakamega continued under Rhodes grass in its first residual year. The response to all three fertilizers is still highly significant and the mean yield of the trial was 64.7 tons of green material/acre for the 12 months of 1961.

Fodder Crops

Legumes Grown with Rhodes Grass and Napier Grass

The two Legumes under trial at Busia are *Centrosema plumieri* and *Dolichos argenteus*. Interplanted with Rhodes grass they have proved to be very satisfactory when managed under a cutting régime. *Dolichos argenteus* contributed 39.2 per cent and *Centrosema plumieri* contributed 23.0 per cent of the grass/legume mixture, both percentages referring to the dry weights. The legumes seemed to have little depressing effect on the Rhodes grass yields, and thus the combined grass and legume mixture produced more fresh material and dry matter per acre. It remains to be seen whether this result will be repeated under a grazing régime. The two legumes have not proved satisfactory with Napier grass. Close spacing of the Napier grass smothers the legumes whereas wide spacing of the Napier grass makes a mixture of grass and legume impractical. At this stage there seems to be little prospect of growing legumes and Napier grass together satisfactorily.

Fertilizers and Napier Grass

The treatments in this trial include the application of superphosphate, C.A.N., and farmyard manure, both separately and in combination, at sites at Kakamega, Busia, Shikusa, Lunyerere and Shitoli. The trials at Shitoli and

Lunyerere have almost completed two seasons. In both these trials the addition of 2 cwt. per acre of double superphosphate in the planting year, and 2 cwt. of sulphate of ammonia every year has nearly doubled the yield over control. The The results are summarized in Table I, the totals presented representing 4 cuts taken over a period of 15 months.

Table I—Yields of Napier Grass in Tons per Acre Fresh Material

	Control	2 cwt. Superphosphate 2 cwt. Sulphate of Ammonia	10 Tons F.Y.M.
Lunyerere	56·9	104·5	100·7
Shitoli	39·1	70·6	45·9

In the Shikusa trial there is at present little difference between the F.Y.M., fertilizer, and combined F.Y.M. and fertilizer treatments. Rates of application are similar to those above except that the superphosphate is applied at 3 cwt. per acre every year. Results from the remaining sites are inconclusive.

Grassland

Ley Establishment Trial

This trial which compares the establishments of Rhodes grass and Molasses grass under beans and maize, with fertilizer treatments incorporated has been referred to in previous reports; it was completed this year, having first been started in 1959. The trial has proved once again in this season that a good grass crop can be established under maize with no apparent depression of maize yields. In actual fact undersowing with Rhodes and Molasses grass resulted in an appreciable increase in the yield of maize, although it did not reach a statistically significant level. On the other hand, undersowing the grasses to beans resulted in the failure of the bean crop, which was smothered by the undersown grass. The assessment of the grass cover for the various treatments is given in Table II.

Table II—Percentage Grass Cover

Treatments	%	L.S.D.'s
Rhodes grass alone	75	5% = 9·21
Beans with Rhodes grass ..	72·5	5% = 9·21
Beans with Molasses grass ..	71·25	1% = 12·89
Molasses alone	70·0	0·1% = 17·93
Maize with Molasses grass ..	66·25	
Maize with Rhodes grass ..	47·50	

The comparatively poor Rhodes grass cover resulting from undersowing to maize much improved after one year's grazing; at this stage the undersown Rhodes grass was almost equal to the direct sown treatment. The yields obtained from eight cuts are presented in Table III.

TABLE III—YIELDS IN TONS PER ACRE OF GREEN MATERIAL

Rhodes alone	20·15
Beans and Rhodes	11·77
Maize and Rhodes	18·56
Maize alone	12·93
Beans alone	26·07
Maize and Molasses	29·08
Beans and Molasses	21·10
Molasses alone	14·86

F.Y.M. and superphosphate had little effect on the grass cover at harvest, but made an appreciable difference in grass yields over the year.

Food Crops

MAIZE BREEDING TRIALS

Evaluation trials have continued at Kakamega and throughout the Province. The results of these will be reported on by the Plant Breeder, Kitale.

MAIZE TIME OF PLANTING TRIAL

This trial, designed to investigate whether early planting of maize results in a higher yield, was carried out at Busia and Kakamega. The Busia trial is not yet completed at the time of writing this report. Eight times of planting at two-week intervals were compared in a randomized block design at Kakamega. The first planting date was 4th March. All plots were split for fertilizer and no fertilizer treatments. A summary of the results is presented in Table IV.

TABLE IV—YIELDS OF MAIZE IN LB. PER ACRE

Time of Planting	Fertilizer		Planting Means
	With	Without	
4–3–61	8,625·9	6,158·8	7,392·3
18–3–61 ..	7,145·8	4,237·5	5,691·6
1–4–61 ..	6,858·9	4,059·9	5,459·4
15–4–61 ..	4,713·7	2,985·6	3,849·6
29–4–61 ..	1,990·8	1,295·1	1,242·9
13–5–61 ..	366·8	164·6	265·7
27–5–61 ..	—	—	—
10–6–61 ..	—	—	—
Fertilizer Means	3,712·7	2,362·7	

L.S.D.'s—

5% = 636·2
1% = 865·9
0·1% = 1,168·1

It can be seen from the results of this trial that early planting at Kakamega in 1961 was definitely advantageous, resulting in a higher yield of grain. Maize planted 2½ months after the beginning of the rains produced no yields at all. Yields dropped consistently from the first time of planting. The yields of the manured plots were considerably higher than those of unmanured plots, but these differences grew smaller with lateness in planting. Lateness in planting resulted in a progressively smaller percentage of large cobs, with the percentage of large cobs being always greater in the manured plots. Similarly there was a progressively higher percentage of discoloured and diseased cobs, so that late planting resulted in less edible grain. The manured plots showed a similar decline but were always superior to the unmanured plots. Treatments planted six weeks and later after the beginning of the rains had a progressively larger number of plants bearing no cobs. It was observed that manuring resulted in less lodging.

The mean yield for the earliest planting plus fertilizer was 43 bags per acre which indicated the high potential of maize in the Kakamega District.

Soya Beans

Two Nyasaland varieties of Soya beans, released from quarantine at the beginning of the year, were put in a trial with three other varieties which have previously been tried. The five varieties comprise Hernon (local), Hernon (ex Belgian Congo), R.184, Bukoba and Bukura. This trial was planned to be statistically analysed but it was upset by very poor germination of Bukoba in two blocks. The results are summarized in Table V. It is concluded that both R.184 and Hernon (local) may have considerable value in this district, especially with their early maturity, which would allow them to be grown as short rain crop.

Table V—Yield and Time of Maturity of Varieties of Soya Beans

	Yield in lb. per acre	Days to Maturity
Hernon (local)	1,952	116
Ex Belgian Congo	1,688	130
R 184	1,633	116
Bukoba	1,530	124
Bukura	686	132

Bananas

Thirteen banana varieties have been grown in an observational trial at Bukura with the object of choosing the best varieties for the future cultural experiments. Yield records have not been obtained due to considerable pilfering. The main factors taken into account were the vigour of the variety, knowledge of its production, and its palatability. Notes were made on each variety in order to make it easier to recognize and name certain types or varieties in the field. Palatability proved to be quite differently regarded by Europeans and Africans. The latter gave their order of preference as follows:—

For Cooking	*For Eating Raw*
Shisikame.	Sukari.
Isianamuli.	Uganda Red.
	Sherembe.

These observations are preliminary to the commencement of further trials with the most promising varieties in 1962.

Cash Crops

Castor Oil

Local and commercial varieties of castor oil were tested in an observational trial at Kakamega. Six spacing treatments were also included. Records were made on the yield, oil content, habit of growth, shattering, seed characteristics, ease of harvesting and ease of shelling by hand or by machine. Kakamega is not wholly suited to castor seed production and therefore yields are rather low. However with the trial at Kakamega there has been ample opportunity to study the crop and to decide which factors are important in selection, and as an outcome of this trial the selected varieties for which records are given in Table VI will be put into a statistical trial in a more suitable area in 1962.

Table VI—Characteristics of Selected Varieties of Castor Oil

Variety	Best Spacing	Oil Percentage	Habit of Growth	Yield clean beans per acre in lb.
N N "D"	6′ x 4′	46·1	Medium Dwarf ..	120
N N "F"	6′ x 4′	50·3	Tall	443
Large Red Mottle..	4′ x 4′	51·0	Tall	600
Connor	6′ x 4′	48·0	Medium Tall ..	180
Large Grey Mottle	4′ x 4′	49·4	Tall	208
CN "1"	6′ x 6′	42·0	Medium Tall ..	309
UC. 53	4′ x 4′	49·0	Medium Dwarf ..	583
Maunthner.. ..	3′ x 3′	48·5	Tall	161
Mamona	3′ x 3′	46·9	Dwarf	87

Safflower

Six varieties of safflower (*Carthamus tinctorius*) were grown in observational trials at Kakamega and Namasoli. Results were disappointing. Disease seriously affected four varieties. Two main symptoms were observed; *Gloeosporium* has been identified as one cause. There were considerable varietal differences in susceptibility to the diseases. At harvest a considerable amount of seed was lost from sprouting in the head during the exceptionally wet weather. Safflower is worth further trial as a short rains crop.

Cocoa

The "Forestero" cocoa seedlings, planted at six sites in Elgon, North and Central Nyanza in March, April and May of 1960 have failed. The environment appears to be the cause of failure and not pests or diseases. The two probable limiting factors were soils and humidity, the extreme dry season extending over December, January and February of 1960/61 also contributing to the failure. There may be isolated areas in river valleys suitable for the cultivation of cocoa in Nyanza, but the total area would be very restricted.

SUGAR

Variety Trials.—The trials comprising five varieties of cane planted on the Martin silty clay at Muhoroni was harvested in March. The yields for the plant crop are presented in Table VII. The yield of Co 419 cannot be taken as the true potential of this variety because of theft.

TABLE VII—YIELDS OF CANE AND SUGAR IN TONS PER ACRE

Variety	Cane	Sugar
Co 331	88·99	6·925
Co 421	70·85	6·718
Co 301	58·35	5·529
Nco 339	55·96	5·349
Co 419	22·63	1·832
L.S.D.'s 5% =	22·44	2·068
1% =	31·47	2·899
0·1% =	44·48	4·097

COMPARISON OF THE EFFECT OF SIX NITROGENOUS FERTILIZERS ON RATOONED SUGAR-CANE

Five different nitrogenous fertilizers were compared in a 7 × 7 latin square imposed on established Co 421 sugar-cane on the heavy soil at Miwani. There were no treatment differences of a significant nature either in cane or sucrose yields. The treatment details and summary of results for cane weights are shown in Table VIII.

TABLE VIII—YIELDS OF CANE IN TONS PER ACRE

Treatment	*Tons/Acre*	
Urea. 1 cwt. p.a.	41·19	
N A C. 3 cwt. p.a.	40·02	L.S.D.'s 5% = 4·68
S/A. 3 cwt. p.a.	39·54	1% = 6·30
Diamon Phosphate. 3 cwt. p.a.	39·34	0·1% = 8·35
Urea. 2 cwt. p.a.	38·61	
A S N . 278 lb. p.a.	38·28	Coefficient of Variance 10·8%
Control	37·92	

POOR LAND IMPROVEMENT TRIAL WITH SUGAR-CANE

This trial on the heavy Kano plains clay at Miwani is designed to obtain information on the effects and rates of green manure which might substantially improve this poor land. For comparison cane trash at equivalent rates on the basis of dry matter content are included and in order to study the nitrogen factor, both urea at rates equivalent in N to the green manure, and the same levels of urea as a fortification of the cane trash treatments, have also been included. Finally the effect of gypsum is studied, applications comprising two tons and four tons per acre. The plant crop, harvested in November, 1961, gave no significant differences in the cane yields but the sucrose results were more interesting. These are presented in Table IX as mean yields.

TABLE IX—YIELDS OF SUCROSE IN TONS PER ACRE

		Green Manure	Urea	Trash	Trash + Urea	Means
Levels equivalent to (1) 10 tons.	1	5·036	5·427	5·383	5·347	5·297
(2) 20 tons green manure.	2	5·697	5·375	5·799	5·048	5·477
Gypsum at (1) 2 tons	1	5·366	5·859	5·837	5·327	5·597
(2) 4 tons p.a.	2	5·357	4·942	5·344	5·064	5·177
Means		5·361	5·400	5·591	5·195	5·387

Means of 8 *Plots*
L.S.D.'s 5% = 0·293
1% = 0·358
0·1% = 0·572

2 *Means of* 16 *Plots*
L.S.D.'s 5% = 0·207
1% = 0·254
0·1% = 0·404

From the results of this trial the high rate of gypsum application cannot be recommended since it has resulted in a significant depression of cane yields. The lower level of two tons per acre has given very good results especially when applied in combination with urea and cane trash. There was no significant difference between the main treatments, but there is a tendency for the higher level of each to produce a better yield.

DEEP PLANTING AND RIDGING OF SUGAR-CANE

Two experiments, one on the lower heavy soil at Miwani and the other on the upper light soil were harvested in September, 1960. Both were designed to compare planting of sugar-cane on the flat with planting in trenches combined with different times of earthing up and also the two varieties, Co 331 and Co 419. Results were obtained from the plant crops in both experiments; these showed no significant differences between treatments.

FERTILIZER RATES TRIALS WITH SUGAR-CANE

Three 3^3 factorial fertilizer rates trials were harvested in the Chemelil/Kibigori area during 1961. The treatments included the factors N, P and S at three levels comprising (1) urea at 0, 1¼ and 2½ cwt. per acre, (2) double superphosphate at 0, 1 and 2 cwt. per acre and (3) gypsum at 0, 1½ and 3 cwt. per acre. In the first trial on the Patel Clay at Chemelil no treatment was significant. On the Chemelil clay loam the treatment effects as measured by the cane weights just failed to be significant on the F test, but in the analysis of sucrose weights the main linear effect of nitrogen was significant. The response to 1¼ cwt. of urea was 28.81 per cent, and the response to 2½ cwt. of urea was 47.02 per cent, significant at 1 per cent. On the Tennant Clay no treatment was significant as measured by the sucrose or cane weights.

HERBICIDE TRIAL ON SUGAR-CANE

This trial using Simazine, T C A and Agroxone—four in various combinations was successfully concluded in April, 1961, on the lower heavy soil at Miwani. All herbicides were applied pre-emergence and recordings and observations were made on germination of the sugar, weed cover and ratio of monocotyledonous to dicotyledonous weeds.

Germination counts on the sugar-cane showed up no statistical differences between treatments. Weed cover scores are given below in Table X, together with details and cost of treatment.

TABLE X—HERBICIDE TREATMENTS, WEED SCORES AND COSTS OF TREATMENTS

Treatment	Mean Score Max. = 10	Cost of Spray Shillings per Acre
Agroxone 4, 8 pints/acre .. .. T C A, 15 lb./acre	3·22	83
Simazine, 3 lb./acre .. .. .. T C A, 15 lb./acre	4·99	107
Agroxone 4, 8 pints/acre	6·83	45
Simazine, 1 lb./acre .. .. .. T C A, 15 lb./acre	7·05	61
Simazine, 3 lb./acre	9·16	69
Control..	9·27	—
Simazine, 1 lb./acre	9·50	23

L.D.S.'s 5% = 1·82
1% = 2·55
0·1% = 3·61

It was calculated that the current estate methods of weeding on the same soil type cost Sh. 61/90 per acre excluding depreciation of machinery. The best two treatments gave adequate chemical control and no cultivations were necessary. It is apparent that although none of these treatments can be recommended as a replacement of present methods just now, complete chemical control or a combination of chemical and mechanical weed control is an alternative which could be brought into use should the balance in costs shift slightly in favour of chemical control.

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APPENDIX

Rainfall at Selected Stations (Inches)

	Shikusa T.C.	Bukura	Kano I.S.	Busia	Kibos C.S.	Kisumu Marine	Miwani Mill	Kakamega	39 Years Average: Kakamega
January	0·56	0·37	0·20	0·82	0·22	0·06	0·84	—	2·29
February	0·75	3·60	1·95	1·99	3·49	2·43	3·47	1·19	3·56
March	1·61	6·77	3·91	8·25	5·97	7·90	5·99	6·35	5·80
April	6·57	10·29	6·42	12·54	8·20	5·83	4·52	9·08	9·92
May	8·86	12·49	6·25	14·38	6·56	4·81	4·82	8·84	10·69
June	6·52	3·91	1·15	3·13	1·24	0·73	1·03	4·04	7·60
July	8·72	3·17	0·03	3·52	1·06	5·01	1·60	4·41	6·84
August	11·86	6·92	3·55	5·03	3·82	3·40	4·17	9·90	8·53
September	15·70	9·90	4·34	10·66	6·16	6·68	5·32	10·01	6·10
October	13·69	9·65	5·83	12·19	5·10	3·50	3·82	9·73	4·9
Nobember	13·81	14·00	17·64	13·19	18·28	11·03	19·47	21·70	3·98
December	9·02	6·52	10·59	6·75	10·89	6·34	10·50	10·15	3·37
Total	97·67	87·59	61·86	92·45	70·99	57·72	65·55	95·76	73·96

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH) SOUTHERN DIVISION, NYANZA PROVINCE

Weather

Rainfall at Experimental Stations 1961

The monthly totals from the Stations are given in Appendix A.

In the Kano Plains areas, with the exception of Kibos, rainfall was below average until the advent of the excessive and unseasonal rains in November and December. In the Southern Division, the same applied except that the heavy rains began even earlier in Kisii and Bomet.

Reports on Experiments

Fertilizer Rates Trials

On a Monieri Clay Loam, a 3^3NPK trial, on maize in its second year, showed that residual phosphate gave a highly significant response in yield but increased significantly the lodging effect. Nitrogen and potash had no apparent effect. On a Phonolite soil, a 3^3 NPK trial on maize in its third year (4th residual) showed that residual phosphate still gave a significant response in yield, but that the effect of FYM had completely disappeared.

Maize Fertilizing Trials

At Songhor a maize trial was conducted, comparing three rates of nitrogen—0, 45 and 90 lb. per acre N as A.S.N., and three methods of application—all at planting, half at planting and half at knee height, and all at knee height. In the analysis of yield of dry grain, a significant response was observed to nitrogen application at the rate of 346 lb. of A.S.N. per acre. The observed increase was 897±378 lb. of grain per acre at 5 per cent significance. No significant increase resulted from the lower application of A.S.N. nor was there any evidence that different methods of application resulted in different yields. In the analysis of the lodged plants, a significant reduction in the number of lodged plants was found where plots had been top dressed. There was no significant difference between the numbers of lodged plants associated with the methods of application. A dressing of A.S.N. at planting had no effect on stand.

At Sotik a 3^3 NPM trial was laid down on maize with each plot split for six varieties. The results are given in the tables hereunder in lb. per acre:—

P_0	4,957	L.S.D. at 1% 375
P_1	5,747	
P_2	5,698	

M_0	4,957	L.S.D. at 1% 375
M_1	5,857	
M_2	5,587	

Kitale Synthetic II	6,127	L.S.D. at 5% 407
Station Maize	5,849	
Tarakwa Farm	5,726	
Kericho District I	5,204	
Buchanan's	5,189	
Kericho District II	4,707	

The lower dressing of triple superphosphate (2 cwt. per acre) gave an economic increase of 790 lb. per acre, significant at 1 per cent. No increase was obtained from the extra 2 cwt. per acre of triple superphosphate given in the higher level of dressing.. The lower dressing of FYM (5 tons per acre) gave an economic increase of 900 lb. per acre, significant at 1 per cent. No increase was obtained from the extra 5 tons per acre of FYM. Nitrogen produced no significant response in yield.

As for varieties, Kitale Synthetic II was outstanding. It outyielded the three lowest yielding varieties at the 5 per cent significance level and just failed to reach this level over Tarakwa Farm maize (401 lb. against 407 for a significant difference).

The Sotik Station maize also performed well. There was no evidence that varieties responded differently to fertilizer application. These results were reflected largely in the analysis of the number of good cobs, except that there was no response to the phosphate dressings.

Fodder Crops

Of the six species of fodder grass tried at Sotik only Napier grass and *Setaria splendida* show any promise. Because of poor cover *Panicum makarikariensis* and Ronpha grass plots have been invaded by couch grass. Conditions at Sotik are too dry for Guatemala grass, as its brief but spectacular improvement in the heavy November and December rains showed. Even *Setaria splendida* is not really in its element and *Panicum maximum* is, as always in this area, second rate. Only Napier grass produced a reasonable yield in its third year although it too is now invaded by couch.

The trial at Kisii of Napier grass, *Setaria splendida* and *Panicum makarikariensis* was continued into the third year and two more cuts were taken prior to abandoning it because of invasion by couch, and a drastic reduction in yield of fodder.

Over the three years Napier grass just outyielded *Setaria splendida*, but at no cut significantly. Considered purely as a fodder, a large part of the lower stem of the Napier grass is completely wasted, whereas all the Setaria is good fodder. This makes Setaria the more profitable grass to grow in this high rainfall area, apart from its higher D.M. and protein content. In this trial it was shown that Setaria responded well to a 10-ton dressing of FYM whereas no similar response was recorded with Napier grass or *Panicum makarikariensis*. The mean yields of green matter in tons per acre for two cuts taken in each of the three years are given below:—

	1st year	2nd year	3rd year
Napier	35·86	29·92	13·07
Setaria	34·12	28·41	13·20
Panicum	5·65	6·53	1·83

A Napier grass trial at Kisii incorporated fertilizer and FYM treatments, weeding *v.* no weeding and cutting at 2 feet above ground level and ground level. The indications were that cutting at the 2 feet stage produced as much green material of good quality as the more drastic cutting at ground level, and whereas no weeding in the latter treatment reduced the yield by 20 per cent, there was no corresponding reduction in the plots cut at the 2 feet stage.

The Sotik lucerne variety trial continued into 1961 but was found to be very gappy and was eventually abandoned. However, the result in favour of the variety Saladino was too convincing to be ignored. The results are presented hereunder:—

Total of 5 cwt. in Tons Dry Matter per Acre

Saladino	2·96	Booberowie ..	2·33
Monastic	2·68	Provence	2·26
Italian	2·58	Hunter River ..	2·22

GRASSLAND

An observational trial was laid out on Mr. Young's farm at Sotik on a uniform sward of approximately 75 per cent *Pennisetum catabasis*. The object was to find out the best method of eliminating this undesirable grass, and treatments included burning *v.* no burning, Dalapon spot treatment, mowing, grazing and tilling with a reseeding of oats and Ruepell's clover (indigenous) sown with 100 lb. per acre of triple supers. The only effective treatment was mowing. The experiment was started in July, 1959, and, exactly two years later, the mowing treatments carried out only over the first 18 months, still stood out with a mixture of *Hyparrhenia rufa*, Red Oat, *Setaria sphacelata*, and Star grass, against a thick background of *Pennisetum catabasis* apparently completely unaffected by any other treatment.

Apart from the burning facilitating the first mowing it had no lasting effect. The first mowing took place one month after the August burning treatment. In January plots were mown again, and the last mowing took place in December, 1961, by which time very little *Pennisetum catabasis* was left. The conclusion is that an initial burn will facilitate the first mowing, but that it is not an essential. Three spaced mowings over 18 months will eliminate the *Pennisetum catabasis*.

An experiment was laid down at Sotik to examine the effect of phosphate on the establishment and subsequent production of a Nandi Setaria and Kenya white clover ley.

The different phosphate applications were as follows: 4 cwt. per acre triple supers on establishment (P_1), 2 cwt. per acre triple supers on establishment and 2 cwt. per acre at the start of the third year (P_2), 1 cwt, per acre triple supers on establishment and a further top dressing of 1 cwt. per acre each year (P_3), 1 cwt. per acre triple supers on establishment only (P_4), and control (1).

All treatments were broadcast. The results in tons per acre of green matter are presented below:—

	1959/60	1960/61	1961/62
P_1	18·87	16·41	11·11
P_2	18·64	11·60	10·79
P_3	17·10	13·05	9·72
P_4	15·83	13·34	8·25
(1)	14·64	13·43	8·57

It is still too early for the results to be fully conclusive since the P_3 treatment is not yet complete. More reliable conclusions can be drawn next year, at the end of the four-year cycle. It is however to be noted that, in the first year, 2 cwt. per acre of triple supers was apparently sufficient for the ley's current needs. P_3 and P_4 were identical treatments for that year and, if combined, indicated a linear response up to 2 cwt. per acre. In the second year the lack of any further phosphate application in P_2 showed up, by comparison, the residual response to P_1 arising from the reserve of phosphate remaining from the first year. In the third year the extra 2 cwt. triple supers, applied in P_2, have brough up the yield to about the same as P_1, but has not of course compensated for the drop in the second year. The additional 1 cwt. per acre being applied annually to P_3 is apparently having its effect, but there is a lot of leeway for it to make up in the fourth year. The single 1 cwt. dressing of P_4 has lost all residual effect, as it had even in the second year. So far the indications are in favour of a large dressing of phosphate at planting time.

A trial to test the effect of gypsum and superphosphate on the establishment and growth of a Rhodes grass and Kenya white clover ley has been undertaken at Sotik. In this trial, which was carried over into the second year for two cuts, both the phosphate and gypsum continued to give significant responses, but the phosphate was much more important and the interaction was not significant. The results are summarized below.

Yields in Tons/Acre

	Superphosphate cwt./acre			
	0	1½	3	Mean
Gypsum cwt./acre 0	0·63	±0·27 (1) 2·80	3·72	±0·15 (2) 2·38
Gypsum cwt./acre 1½	0·62	3·07	4·15	2·61
Gypsum cwt./acre 3	1·04	3·17	4·99	3·07
Mean	0·76	±0·15 (3) 3·01	4·29	2·69

A ley species trial also at Sotik, laid down in 1958, comprised a comparison between Nzoia Rhodes grass, Nandi Setaria and Star grass combined in a factorial design with Louisiana white clover and Kenya white clover. All plots were split for phosphate and no phosphate and further split for gypsum and no gypsum. In the third year (1960) the Rhodes grass had fallen disastrously in yield, whereas the Star grass, which had previously been the worst of the three grasses had risen to equal Nandi Setaria. The indication was that Star grass would take the lead in the fourth year. All phosphate and gypsum effects had faded out. Very little clover of either kind remained, but slightly more of the Kenya white than of the Louisiana white. In the fourth year Nzoia Rhodes grass production continued to fall, but Nandi Setaria continued to outyield Star grass by 12 per cent. The fourth year results are given below.

Yields in Tons/Acre (*2 cuts only*)

Nandi Setaria	0·707
Stargrass	0·631
Nzoia Rhodes grass	0·450

A trial to test the effect of nitrogen on the production and persistency of a Rhodes grass/Kenya white clover ley was started at Sotik in April, 1961. It consisted of a Control with four nitrogen treatments randomized in six blocks. The treatments, given in two dressings per annum of A.S.N., were as follows: No nitrogen (1), 35 lb. N per acre (N_1), 70 lb. N per acre (N_2), 105 lb. N per acre (N_3), 140 lb. N per acre (N_4). The experiment has not quite completed a year yet, but the results of three cuts are given below in tons per acre of dry matter.

N_4	N_3	N_2	N_1	(1)
5·41	4·05	3·65	3·39	1·95

L.S.D.'s

5%	1%	0·1%
0·140	0·191	0·258

All increments are significant at 0.1 per cent, but a peculiar pattern emerges. The effect of 35 lb. N is strongly significant and economic, after which further dressings are less effective, which is quite normal. But the jump in yield between the 105 lb. N treatment and the 140 lb. N treatment rivals the effect of the first 35 lb. N. This pattern was very consistent throughout five of the six blocks.

Soya Bean Variety Trial

Seven varieties of Soya beans were compared at Sotik in three randomized blocks. The Belgian Congo variety outyielded all other varieties significantly at the 5 per cent level of probability and all varieties below Venezuela at 0.1 per cent level.

The yields are given below:—

Yields in Lb./Acre

Belgian Congo ..	1,357	R 184	749
T_2	964	Dr. Sanders ..	571
Bukura	960	S 48/103 ..	458
Venezuela ..	945		

L.S.D.

5%	±	295
1%	±	414
0·1%	±	585

Sugar Cane Variety Trial under Irrigation

This trial at Miwani was carried on into a third ratoon crop and has since been ploughed out; owing to a high incidence of sugar cane smut (*Ustilago scitaminea*). It can scarcely be called a true irrigation trial, as a minimum of water was used merely as a means of avoiding check of growth through drought. For each crop and variety the sucrose per cent was obtained by laboratory analysis, so that cane tonnage per acre could be converted to sucrose tonnage per acre. Two tables are given below, comparing varieties, firstly on a cane tonnage basis (Table A) and secondly on a sucrose tonnage basis (Table B). The first 10 varieties only are shown.

Table A—Cane Yields in Tons per Acre

Plant Crop		1st Ratoon		2nd Ratoon		3rd Ratoon	
Co 419	77·50	B 41227	87·74	Co 331	53·43	POJ 2961	43·30
Co 408	73·00	B 37193	76·83	NCo 310	51·30	Co 408	41·23
B 41227	73·00	Co 331	75·78	B 41227	51·14	Co 404	40·57
B 41211	71·00	NCo 310	75·75	B 41211	47·87	Co 331	39·35
B 37193	70·50	Co 419	74·99	Co 408	47·49	B 41227	38·78
Co 331	69·50	Co 408	74·16	B 3215	46·25	M 134/32	38·69
POJ 2961	69·00	B 41211	73·78	POJ 2961	43·85	NCo 310	37·90
Co 421	67·50	Co 421	71·69	PR 809	42·64	B 3337	34·60
POJ 2875	66·00	POJ 2961	71·03	B 37193	42·06	B 3172	32·24
Co 453	65·50	POJ 2725	68·73	Co 419	39·97	Co 419	31·86
..	—	..	—	..	..	..	..
..	..	..	..	..	..	..	..
Mean ..	61·16		63·87		39·27		31·98
L.S.D.—							
0·05	13·85		12·11		8·66		3·47
0·01	18·15		16·42		11·74		4·70
0·001			21·98		15·72		6·29

TABLE B—SUCROSE YIELDS IN TONS PER ACRE

Plant Crop		1st Ratoon		2nd Ratoon		3rd Ratoon	
C 419	7·768	B 41227	8·566	Co 408	5·052	Co 408	3·836
B 41211	7·211	B 41211	7·863	NCo 310	4·984	B 3172	3·236
B 41227	7·057	NCo 310	7·725	Co 331	4·938	Co 331	3·173
Co 408	6·819	Co 419	6·939	B 3215	4·934	M 134/32	3·129
B 37193	6·720	Co 421	6·897	B 41211	4·837	Co 419	2·919
Co 421	6·706	B 37193	6·710	B 41227	4·751	POJ 2875	2·909
M 134/32	6·636	POJ 2911	6·697	POJ 2725	4·541	POJ 2961	2·809
NCo 310	6·539	PR 809	6·504	PR 809	4·330	NCo 310	2·747
NCo 291	6·255	Co 408	6·149	POJ 2961	4·300	B 41211	2·682
POJ 2875	6·237	M 134/32	6·017	B 3172	4·229	Co 404	2·677
..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..
Mean ..	5·825		5·907		3·923		2·414
L.S.D.—							
0·05			1·141		0·831		0·262
0·01			1·547		1·126		0·355
0·001			2·071		1·507		0·475

The following two tables compare the consolidated yields for a three-crop cycle (Table C) and for a four-crop cycle (Table D).

TABLE C—YIELDS CONSOLIDATED OVER THREE CROPS

Three Crop Yields

Cane		Sucrose	
B 41227	211·88	B 41227	20·374
Co 331	198·71	B 41211	19·911
Co 408	194·65	NCo 310	19·248
B 41211	192·65	Co 419	18·419
Co 419	192·46	Co 408	18·020
NCo 310	192·05	Co 421	17·554
B 37193	189·39	B 37193	17·231
POJ 2961	183·88	POJ 2961	16·920
Co 421	177·94	B 3215	16·644
POJ 2875	167·93	M 134/32	16·445
..	..	..	..
..	..	..	..
Mean ..	164·30		15·655

TABLE D—YIELDS CONSOLIDATED OVER FOUR CROPS

Four Crop Yields

Cane		Sucrose	
B 41227	250·66	B 41227	23·005
Co 331	238·06	B 41211	22·593
Co 408	235·88	NCo 310	21·995
NCo 310	229·95	Co 408	21·856
POJ 2961	227·18	Co 419	21·338
Co 419	224·32	Co 421	19·742
B 41211	223·65	POJ 2961	19·729
B 37193	216·22	M 134/32	19·574
Co 421	207·83	Co 331	18·937
B 3337	200·62	B 37193	18·880
..	..	..	..
..	..	..	..
Mean ..	196·28		18·069

It has been suggested that, where the cost of irrigation is low and a minimum is given, the crop level may be maintained sufficiently high to warrant taking a third ratoon. Even with fertilizer application the mean yield of cane in this trial dropped 22 tons by the second ratoon, and nearly 30 tons by the third. The outright winner dropped 22 tons by the second ratoon and 35 tons by the third. At this rate of loss there is even a case for ploughing out after the first ratoon, and there certainly seems to be nothing in favour of keeping a trial on to the third ratoon.

The results for the third ratoon have been given here merely as an illustration. Many varieties were badly attacked by sugar cane smut and this may have contributed partly to the low yields. It is nevertheless unlikely that they would have exceeded those of the second ratoon. Keeping yields at a level of 39 tons per acre for the last two ratoons means a combined loss of 44 tons per acre compared with the plant crop and first ratoon, even assessing these both at the mean figure of 61 tons per acre attained by the plant crop. Yields consolidated after the second ratoon are therefore the best guide to the relative performances of these varieties and these can be seen in the last table, where yields of sucrose and cane are presented side by side. It is interesting to note that of the first time varieties in order of cane yield, eight of these occur in the first nine varieties in order of sucrose yield, and B 41227 is an outright winner in both.

Both B 41227 and B 41211 were absolutely clear of smut as was NCo 310 and Co 408. Co 419 was only slightly infected, in contrast to its behaviour in dry land trials, but Co 421 was badly infected in one replicate. Co 331 was also infected in one replicate but at a level of under 0.5 per cent. B 37193 was infected more than 50 per cent. POJ 2961 was clear.

NCo 310 which tends to arrow very early in dry land conditions at Miwani, showed very little of this tendency when it was subjected to no drought stress and is worth a trial as a full irrigation cane, as of course is B 41211.

C. C. H. HILL,
Provincial Research Officer.

APPENDIX "A"

Rainfall at Selected Stations (Inches)

Month	Sotik	Kisii	Bomet	Kabosson	Homa Bay	Karungu	Miwani (Mill)	Kisumu (Marine)	Kibos	Ahero
January	0·08	0·54	0·56	1·00	0·29	Nil	0·84	0·06	0·22	0·20
February	2·92	6·65	2·61	2·69	3·90	5·00	3·47	2·43	3·49	1·95
March	4·98	6·35	3·39	0·74	5·38	1·66	5·99	7·90	5·97	3·91
April	3·98	7·68	5·05	4·65	5·33	3·68	4·52	5·83	8·20	6·17
May	5·84	7·32	6·06	5·64	7·84	4·05	4·82	4·81	6·56	6·25
June	2·51	6·17	1·30	1·84	1·91	1·41	1·03	0·73	1·24	1·15
July	1·25	1·82	Nil	0·05	4·76	1·20	1·60	5·01	1·06	1·09
August	3·35	4·07	3·05	4·32	4·94	0·69	4·17	3·40	3·82	4·34
September	4·83	7·18	1·92	0·60	6·15	1·96	5·32	6·68	6·16	4·34
October	5·64	10·41	13·57	2·19	4·00	4·82	3·82	3·50	5·10	5·83
November	13·69	19·52	20·00	16·48	14·11	17·62	19·47	11·03	18·28	23·03
December	9·61	5·87	16·72	7·73	5·43	5·25	10·50	6·34	10·89	12·74
Total ..	58·68	83·58	74·23	47·93	64·04	47·34	65·55	57·72	70·99	71·00
Average	51·44	?	48·49	36·72	45·77	23·82				
(Years)	(8)		(5)	(4)	(11)	(5)				

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), SOUTHERN PROVINCE

Weather

A lot has been said about the contrast of the two seasons of 1961: the failure of the long rains after the poor short rains of 1960 resulted in famine which was aggravated by the floods of November and December. Table I for our two stations shows the pattern of rain we received. At Katumani the long rains were insufficient for most crops but at Kampi ya Mawe sorghums and cowpeas did quite well.

TABLE I—ANNUAL RAINFALL FOR 1961

	KATUMANI (Altitude 5,300 ft.)		KAMPI YA MAWE (Altitude 3,700 ft.)	
	Inches	*No. of days*	*Inches*	*No. of days*
January	0·04	1	Nil	Nil
February ..	0·49	5	0·64	3
March	1·72	6	0·57	5
April	2·71	12	3·87	14
May	1·55	6	3·25	4
June	0·18	2	0·15	1
July	Nil	Nil	0·18	2
August	0·20	1	0·01	1
September ..	0·77	5	0·58	6
October	7·21	12	8·74	19
November ..	19·25	25	17·37	18
December ..	6·26	9	4·52	8
TOTAL ..	40·38	84	38·88	81

UTILIZATION OF SOIL MOISTURE BY VARIOUS CROPS

In Ukambani a rainy season such as the short rains of 1961 may occur twice in a century but a failure like the long rains is probable once in five years. Consequently the study of water use by crops is fundamental to the development of a reliable farming system for the area. For the last four seasons there has been a trial at Katumani to compare the relative water use of various crops. A cycle of the trial is started each season with the following crops:—

Local White maize (5½ months to maturity).

Taboran maize (4 months to maturity).

Local White maize cut as silage.

Beans.

Fallow.

In the second season the plots are split for test crops of local white maize and Taboran maize. These are followed in the third season by a uniform crop of bulrush millet which is cut at full flower for silage. Because the original plot size was 1/10 acre the trial was laid out in a balanced incomplete block design wth six replicates in 10 blocks of three plots per block.

So far two cycles have been completed. These are of particular interest as their final seasons have been in such contrast to each other.

Year	L.R. 60	S.R. 60–61	L.R. 61	S.R. 61–62
Rain	average	average	poor	good
	11·45″	10·56″	5·98″	34·75″

1st cycle →

2nd cycle →

The distribution of rain within each season was satisfactory except for the short rains 1960/1961 when a drought severely checked the crops from their second to sixth week. Tie ridging was used to prevent run off losses and uneven water distribution within the plots.

The yields of the treatment crops in the first season of each cycle were of the order to be expected from yield/rainfall regressions produced by the Plant Breeder at Katumani.

Table II

1st Season's Crops	1st Cycle	2nd Cycle
Local maize, lb./grain/acre	1,200	150–200
Taboran, lb./grain/acre	1,700	800
Beans, lb./grain/acre	870	490
Silage, tons DM/acre	5	2

The yields of the local maize and Taboran grown as the first test crop in the first cycle are presented in Table III:—

Table III—Yield of Taboran and Local White Maizes Following the Five Listed Crops, in Lb./Acre

1st Season's Crops	Local White		Taboran	
	Grain	Stover + Cobs	Grain	Stover + Cobs
Local White	55	8,020	1,003	4,180
Taboran	133	8,810	928	4,300
Silage Maize	207	9,990	912	4,280
Beans	256	9,710	885	4,060
Fallow	1,057	14,280	2,084	6,000
C of V	14%	12%	16%	11%
L.S.D. 5%	N.S.	1,640 lb.	180 lb.	660 lb.
0·1%		3,090 lb.	445 lb.	1,250 lb.

The grain and stover yields of the Taboran have been little influenced by the preceding crop except that the additional water stored in the fallow plots allowed the maize to grow unchecked through the unseasonal drought mentioned above. The local white benefited similarly on the fallowed plots although the grain yield is only half that of the Taboran. A very high coefficient of variation caused

by the droughting of the maize on other treatments does not allow the grain yields to be expressed as significantly different. The stover yields however do show a significant increase (P at 5 per cent) following silage or beans over local white in the first season.

It is interesting to note the relative efficiency of the two maizes as grain producers. With no appreciable rain after the seventh week Taboran on the fallow plots had a grain:stover ratio 1:2 while the ratio of the local maize was 1:12.5. Also the correlation between yield and silk count for local maize is much higher (r = 0.95) than it is for Taboran (r = 0.69). It would seem that the earlier maturing Taboran had silked and partly developed its grain before water stress inhibited growth while the later local maize was wilting before the onset of silking and the grain yield was dependent on the small number of plants which silked before growth was stopped.

The results of the bulrush millet grown in the third season are shown in Table IV. Least significant differences between the means vary as the number of plots of each treatment which were sampled differed due to an accident to the trial.

TABLE IV—YIELD OF BULRUSH MILLET IN THE 3RD SEASON OF THE 1ST CYCLE IN LB. HERBAGE/ACRE

1st Season's Crop	Test Crop		Mean Effect of 1st Season's Crops
	Local White	Taboran	
Local White	590	1,440	1,010
Taboran	1,040	1,960	1,500
Silage Maize	1,260	3,950	2,600
Beans	1,100	2,290	1,690
Fallow	1,730	5,640	3,690
Mean	1,160	3,160	2,150

The effect of growing a short term maize (Taboran) instead of the local maize in the second season is obvious: the growth of millet being over twice as great after the Taboran (L.S.D. at 0.1 per cent = 940 lb.). The effect of the first season's crops are still strongly in evidence, largely reflected through the intermediate crop of Taboran. The depressing effect of two seasons of local maize is striking although not significantly less than two successive seasons of Taboran. There is little residual benefit from the fallow when followed by local maize but Taboran does seem to have made less demand and allowed a subsequent crop to benefit. The sequence Fallow-Taboran is significantly greater than all other crop sequences except Silage-Taboran (L.S.D. at 5 per cent = 1,850 lb./acre). This rather unexpected result from the silage can be explained by the silage being the first crop to be harvested.

Tables V and VI show the results obtained from the second cycle of the trial. The rainfall distribution in the first season did not allow the soil to be wetted to a depth greater than four feet and although the cycle entered its second season with marked differences in residual soil moisture due to the initial crops the quantity of water available was not sufficient to develop a grain crop except after the fallow treatment.

TABLE V—MEAN PRODUCTION OF DRY MATTER IN THE SECOND SEASON IN LB./ACRE BY LOCAL MAIZE AND TABORAN

	Lb./Acre	L.S.D.	
		5%	0·1%
Local Maize	622		
Taboran	566	169	321
Silage maize	603		
Beans	783		
Fallow	2,507		

The better growth of the maize following beans compared to the three maize crops reflects the greater amount of soil moisture left by the beans. The grain yields of the two maizes on the fallowed land were:—

Taboran	440 lb./acre
Local maize	50 lb./acre

showing strikingly the advantage of early silking by Taboran. Taboran did attempt to silk on the other plots and a silk count before the final collapse of the crop produced the following results.

Silk count of Taboran in the second season (silks/acre).

TABLE VI

1st Season's Crop	Silk Count 31–5–61	L.S.D.		
		5%	1%	0·1%
Local Maize	576	822	1,133	1,557
Taboran	1,078			
Silage Maize	1,677			
Beans	1,823			
Fallow	7,888			

Under the conditions of marginal rainfall silk emergence would seem to be a sensitive indicator of the water balance of maize.

The third season in contrast to the other had adequate moisture throughout the growth of the bulrush millet and if moisture was the only limiting factor no differences would have shown up in this season. However, differences were obtained and these related to the first season of the cycle. The intermediate season had no effect nor were there any interactions. This lack of response to the second season in contrast to the results of the first cycle can be attributed to the slight difference in total growth of the two maizes in the poor 2nd season.

Table VII presents the yield of dry matter per acre and the percentage of nitrogen in the dry matter related to the initial crops of the cycle.

Table VII—Dry Matter Production and Nitrogen Content of Bulrush Millet in 3rd Season of 2nd Cycle

Crop in 1st Season	DM/Acre	Percentage N in Dry Matter
Local Maize	2,347	1·31
Taboran	2,891	1·52
Silage	3,074	1·57
Beans	3,351	1·58
Fallow	4,068	1·72
L.S.D. 5%	560	0·17
1%	772	0·24
0·1%	1,061	0·33

As water was not the limiting factor at any stage in the growth of the millet some other factor must have been operating. At this stage it would seem that available nitrogen is a possible explanation and that the differential removal by the crops in the first season persisted through the dry second season to benefit the crop grown in the third season. If this is the case the results observed in the first cycle of the trial must be an interaction of moisture and nitrogen with, at this stage, the relative contribution by each factor being unknown.

The Spacing of Maize Silage Crops Under Conditions of Low Rainfall

As indicated in the preceding section the stage of growth at which a maize grain crop begins to wilt determines the final yield. Consequently the interaction of spacing and rainfall on yields is of prime importance with maize grain crops. This relationship has been determined for Taboran and local maize in Machakos District (Dowker, *E. Afr. agric. For. J. (in press)*). The considerations for silage maize are somewhat different. The daily energy requirements of stock in the dry season in Machakos district are not hard to satisfy but the available protein is frequently insufficient. The object with a silage crop therefore is to obtain maximum bulk with as high a crude protein content as possible. Two trials to study the relationship of maize variety, spacing and time of cutting with rainfall have been carried out during the short rains 1960/61 and the long rains 1961.

Table VIII—Total Dry Matter Yield of Maize Silage Trials in Lb./Acre

Spacing	2′ x 6″	2′ x 9″	2′ x 12″	2′ x 15″	L.S.D. 5%	Rainfall
S.R. 1960–61	3,730	3,680	3,840	3,640	1,300	10·03′
L.R. 1961 ..	485	484	460	487	195	4·92′

The table combines the result of both trials for the two seasons. The optimum spacing for maize grain is a little lower than 2 ft. × 15 in. (17424 plants/acre) but for silage the population may be increased considerably (2 ft. × 6 in., 43560 plants/acre) with no loss of production.

One of the trials in the short rains incorporated time of cutting with spacing, the other variety with spacing. The results are shown in Table IX and X.

TABLE IX—DRY MATTER YIELD OF EARLY SYNTHETIC MAIZE CUT AT 50% SILKING THEN AT WEEKLY INTERVALS, IN LB./ACRE

50% Silking	1 Week Later	2 Weeks	3 Weeks	4 Weeks
3,700	3,570	3,900	3,960	3,470

L.S.D. at 5% = 640 lb./acre.

TABLE X—DRY MATTER AND CRUDE PROTEIN PRODUCTION OF THREE VARIETIES OF MAIZE IN LB./ACRE

	Taboran	Early Synthetic	Local Maize	L.S.D.
Dry matter ..	3,880	3,520	3,740	470
Crude protein ..	318	315	376	44

The rainfall during the short rains was only slightly below average with most of the rain falling late in the season. Wilting began about one week after 50 per cent silking of the Early Synthetic. No advantage was gained by leaving the maize beyond silking. Taboran silks 4-5 days earlier and local maize 10 days later than Early Synthetic. The three varieties were cut when wilting had become permanent so that Taboran had well formed cobs while local maize was just beginning to silk. Dry matter production of the three maizes was similar but the local maize being more immature had a higher crude protein content than the others: 10 per cent crude protein as compared to 8 per cent.

These results need two more seasons for confirmation but the following interpretation seems plausible.

In contrast to grain maizes a late maturing maize for silage has the following advantages for low rainfall areas:—

(*a*) The maize is still in an immature phase when the limited rainfall is used up and it still has a high crude protein content.

(*b*) In the event of better than average rains the late maize is capable of greater growth before passing out of its immature phase at silking.

Although a high plant population has greater water demands than a low one and with low rainfall results in earlier wilting there is no corresponding loss of yield. The earlier wilting can be an advantage in stopping growth at a more immature age, thus retaining a high percentage of crude protein.

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Agricultural Officer (Research).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), COAST PROVINCE

Rainfall records for the two Research Centres:—

	Mtwapa	Msabaha
	in.	*in.*
January	—	—
February	1·44	1·07
March	1·05	0·76
April	7·01	5·09
May	1·38	5·56
June	3·91	4·42
July	10·81	14·10
August	3·26	4·27
September	12·24	22·74
October	9·47	8·67
November	9·52	11·66
December	4·84	5·08
	64·93	83·42

As may be seen from the above figures, the long rains were light in April, and at Mtwapa, this was followed by a month of drought with only 1.38 in. Heavy rainfall during the latter half of the year seriously interfered with the harvesting of all crops, especially cotton.

Records are no longer presented for Matuga, which closed down in 1961, except for the citrus orchard.

Cotton

Variety Trial—Msabaha

In a randomized block with three replications, three Albar hybrids were compared with U.K.58 and U.K.51, the latter being the standard variety grown on the Coast. U.K.51 matured later than the other varieties and gave the lowest yield of seed cotton. However, differences in yields of seed cotton do not reach significance. All plots of G2. 1/18/161 had a number of plants infected with Fusarium Wilt during the dry weather early in the season.

Yield of Seed Cotton in Lb./Acre

G 2. 1/18/161	UK. 51	121/17/174	UK. 58	67/17/86
1,691·2	1,305·5	1,757·1	1,793·7	1,676·3

L.S.D. 0·05 576·0

Seed Dressing Trial—Mtwapa

Eight fungicidal seed dressings were compared by doing germination counts on cotton seedlings. 828 seeds were sown in each plot. The design was a randomized block with three replicates.

Mean Germination Percentages

Control	41·9
U.C. 7	52·2
Cuprous Oxide T.M.T.D.	54·3
U.C. 1 Thiram	52·3
U.C. 6 Thiram	44·1
U.C. 7 Thiram	54·2
Cuprous Oxide 45%	49·7
U.C. 6	47·3
U.C. 1	46·3

L.S.D.	
0·05	0·01
8·7	12·0

Only Control *versus* Other Treatments reaches significance ($P > 0.05$) in an F test.

When planting this trial, two blocks were planted in dry soil, then a heavy shower of rain interrupted planting. After 45 minutes when the rain had stopped, the third block was planted. The difference in germination percentages is very striking.

Germination Percentage

Wet planting	22·0	±	1·92
Dry planting	66·8	±	1·36

Maize

Variety Trial—Mariakani

In the low rainfall area of the hinterland, three short term varieties were compared with the Local White and the *Puccinia Polysora* resistant Local White, in a randomized block with four replications. The rainfall was less than 1.5 in. per month for the first three months of the trial.

Grain yields are extremely low from all varieties, but the Local White maize which has been selected for the much higher rainfall of the Coastal Strip, significantly outyielded the three short term varieties ($P > 0.01$). It also outyielded the P.P. resistant maize by 156.2 lb./acre ($P > 0.05$).

The variety Katumani White gave a relatively high yield of stover compared with the other short term varieties.

	Early Synthetic	Katumani White	Taboran	P.P.	Local White
Grain lb./acre	58·6	42·9	56·6	156·1	314·3
Stover cwt./acre ..	23·3	46·3	13·9	52·1	86·9

	L.S.D.		
	0·05	0·01	0·001
Grain	147·3	206·5	291·9
Stover	24·3	34·1	48·2

Maize/Cotton Alternate Row Cropping Trials—Msabaha and Mtwapa

These trials were laid down to determine the effect on yields and quality of cotton when rows of cotton are interspersed with alternate rows of maize. Plots of 12 ft. × 90 ft. were laid out in a randomized block with seven replications. The pure stand plots were divided into subplots of 12 ft. × 45 ft.

MSABAHA

	Seed Cotton	Maize Grain	Cash
	lb.	*lb.*	*Shs./acre*
½ acre pure stand of each	686·2 (45% A.R.)	1,386·2	692
1 acre alternate row cropping . .	507·5 (41% A.R.)	2,241·0	735

MTWAPA

	Cotton Seed	Maize Grain	Cash
	lb.	*lb.*	*Shs./acre*
½ acre pure stand of each	611·2 (32% A.R.)	671·7	550
1 acre alternate row cropping . .	682·2 (24% A.R.)	684·2	559

At Msabaha, cotton from pure stand plots outyielded the cotton grown in alternate rows by 178.7 lb./acre ($P > 0.05$). Maize grown in alternate rows gave 854.8 lb./acre more than maize in pure stands ($P > 0.01$). At Mtwapa, alternate row cropping gave slightly higher yields of both maize and cotton, but the differences are not significant. Cash returns were greater from alternate row cropping at both sites.

The very low percentages of A.R. Grade cotton may be partially attributed to the very heavy rainfall during the picking season. This is accentuated with alternate row cropping because cotton from these plots was picked later in the season than the cotton grown in the pure stands. It may be necessary to prolong the applications of cotton dust beyond the end of August if alternate row cropping is to be recommended.

Sorghum

VARIETY AND HYBRIDS TRIAL—MTWAPA

In conjunction with the E.A.A.F.R.O. Sorghum Section, three hybrids were compared with Dobbs and TADA Sorghum and Local White Maize, in a randomized block with six replications.

Mean Yields Grain—Bags (200 *lb.*)*/acre*

H 610	H 726	H 727	Dobbs Sorghum	TADA Sorghum	Local Maize
12·3	15·9	8·1	7·2	10·3	7·5

L.S.D. 0·05 1·9
0·01 2·6
0·001 3·5

The yields indicate the value of hybrids and also illustrate the general inferiority of maize as a cereal for the Coast. The hybrids matured earlier than either Dobbs, TADA or Local Maize.

Cassava

Variety Trial—Mtwapa

Sixteen mosaic-resistant varieties ex Amani were screened in a 4 × 4 lattice square trial, with five replications. The roots were harvested 13 months after planting. At weekly intervals throughout the trial, mosaic counts were taken.

Weights of Fresh Roots—lb./acre

5538/117		6,184
54185/11		6,720*
5414/4		6,968
5412/40		7,520*
552/82		8,880
5539/39		9,088*
4763/16		9,256*
5317/21		10,560
5315/39		10,752
46110/8		11,712
5539/33		11,896
4697/4		11,976
5414/11		12,328
5543/19		13,312
46106/27		16,000
53121/22		18,416
L.S.D.	0·05	2,448
	0·01	3,272
	0·001	4,288

*Varieties showing mosaic symptoms during trial.

All varieties above the line have been rejected due to poor yields and/or susceptibility to mosaic. Variety 5314/39 has been rejected because of a very high infection of Brown Streak found in the roots at harvest, as well as unpalatability of the cooked or uncooked roots.

Variety 53121/22 significantly outyielded all other varieties ($P = 0.001$) except 46106/27. Both these varieties are being distributed throughout the Province.

Sugar

Fertilizer Trial—Ramisi

During 1961, a 4 × 3 × 2 N.P.K. factorial trial was laid out under irrigation at Ramisi. Sulphate of ammonia is being applied at 0, 3, 6 and 9 cwt./acre, double superphosphate at 0, 1 and 2 cwt./acre, and muriate of potash at 0 and 1 cwt./acre. Observations to date on tillering, leaf measurements and cane diameter, indicate a linear response to nitrogen, the effect of which is greatly enhanced by 1 cwt./acre double superphosphate.

Grasses

Cenchrus Ciliaris Establishment Trials—Mtwapa

In one trial, root cuttings were planted in 1 ft., 2 ft. and 3 ft. rows with sulphate of ammonia applied at 0, 2 and 4 cwt./acre. The design was a randomized block with three replications. Cuts were taken at the "hay" stage. Samples from the treatments at each of the five cuts during the year were sent for analysis. The results of these analyses have not yet been received from the Scott Laboratories.

Mean Yields of Fresh Grass—Tons/Acre

		Nitrogen Levels			Row With Means
		0 cwt.	2 cwt.	4 cwt.	
Row Widths	3′	18·96	15·92	18·0	17·63
	2′	16·32	16·34	17·40	16·69
	1′	23·42	23·56	25·23	24·07
Nitrogen Means		19·57	18·61	20·61	

	L.S.D.		
	0·05	0·01	0·001
Main Factors	2·63	3·62	4·98
Interactions	4·56	—	—

The response to nitrogen is not significant. The difference between 1 ft. rows and the other two spacings, is highly significant ($P > 0.001$). There are no significant interactions.

In another trial of similar design, sowing rates of 2 lb., 4 lb. and 6 lb. per acre P.G.S. (pure germinating seed) were substituted for the different planting distances. Again, only the data on yields of fresh grass is available at present.

Mean Yields of Fresh Grass—Tons/Acre

		Nitrogen Levels			Sowing Rate Means
		0 cwt.	2 cwt.	4 cwt.	
Sowing Rates	2 lb.	4·98	10·33	13·42	9·58
	4 lb.	4·83	13·94	14·92	11·23
	6 lb.	12·88	14·85	9·04	12·26
Nitrogen Means		7·56	13·04	12·46	

	L.S.D.		
	0·05	0·01	0·001
Main Factors	2·87	3·96	5·44
Interactions	4·97	6·85	9·42

The difference between sowing rates does not reach significance. The response to nitrogen is significant ($P > 0.01$) but there is no additional response with the higher level of nitrogen. The interaction is significant ($P > 0.01$) but there is no clear interpretation of this.

Napier Time of Cutting Trial—Mtwapa

Napier Grass was cut at the 3 ft., 5 ft. and 7 ft. stages. All plots received 6 cwt./acre sulphate of ammonia in two applications in May and November. The design was a 3 × 3 latin square with three replicates.

Yields of Fresh Grass—Tons/Acre

3 ft.	5 ft.	7 ft.
34·06	39·79	50·87

L.S.D. 0·05 — 1·66
0·01 — 2·35
0·001 — 3·41

The difference between all treatments is highly significant ($P > 0.001$).

Samples from all plots have been analysed. The results of twenty-three, nineteen and ten analyses have been received for the 3 ft., 5 ft. and 7 ft. stages respectively. These show mean percentages for crude protein of 14.97 ± 1.68, 12.83 ± 2.16 and 8.65 ± 2.07. In order to assess the yield of crude protein per acre, a conversion figure of 15.40 ± 0.27 per cent dry matter is used. This is a mean of forty-five dry matter determinations carried out from May to August. It is realized that the use of a single figure for dry matter is imperfect for obtaining absolute values of crude protein per acre, since the dry matter content of the grass varies greatly through the year. However, it does serve to produce a comparison between the different stages of cutting.

Mean Yields Crude Protein—Tons/Acre

3 ft.	5 ft.	7 ft.
0·785	0·786	0·678

In order to harvest the grass at the 3 ft. stage, 10 cuts were taken, as opposed to 6 for the 5 ft. stage and 4 for the 7 ft. stage. Due to the intensity of cutting with the 3 ft. stage, the stools are now dying out from the centre.

NAPIER NITROGEN RATES—MTWAPA

Sulphate of ammonia was applied to Napier Grass at 0, 3, 6 and 9 cwt./acre, in six monthly increments from May to October. Treatments were cut when more than 50 per cent of the grass in all replicates of a particular treatment, reached the 5 ft. stage. The design was a 4×4 square with two replications.

Yields of Fresh Grass—Tons/Acre

Nil	3 cwt.	6 cwt.	9 cwt.
27·87	31·01	40·04	44·49

L.S.D. 0·05 — 2·58
0·01 — 3·57
0·001 — 4·94

An application of 3 cwt./acre outyielded the control by 3.14 cwt. ($P > 0.05$). An application of 9 cwt./acre outyielded 6 cwt./acre by 4.45 cwt. ($P > 0.01$). All other treatment differences are highly significant ($P > 0.001$).

From the results of sixteen analyses received so far, the crude protein percentages are 11.78 ± 0.35, 11.89 ± 0.03, 12.52 ± 0.25 and 13.21 ± 1.51 for increasing levels of nitrogen. The dry matter percentage is taken as 16.72 ± 0.02, which is the mean of sixty-four determinations carried out from May to August.

Mean Yields of Crude Protein—Tons/Acre

Nil	3 cwt.	6 cwt.	9 cwt.
0·549	0·616	0·838	0·983

From the above two tables, it is clear that there is some reduction in the response to higher levels of nitrogen as assessed by yields of fresh grass, but this is offset by higher percentages of crude protein.

Percentage Responses to Nitrogen

	Nil	3 cwt.	6 cwt.	9 cwt.
Fresh Grass.. ..	11·27	29·12	10·00	
Crude Protein ..	12·20	36·04	17·30	

Grass Observation Plots—Msabaha

Thirteen different grasses were planted in 10 ft. × 10 ft. observation plots. Of these, nine have become established. *Cenchrus setigerus, Cenchrus ciliaris* "Mbalambala", *Chloris gayana* "Mpwapwa" and *Brachiaria ruziziensis* have been selected for planting on a larger scale in 1962.

Grass Observation Plots—Mtwapa

Columbus grass and Perennial Kavirondo sorghum were planted in 1/10 acre plots with half the plots interplanted with *Dolichos lablab*. Columbus grass became established very quickly and was very productive throughout the season. Where it was interplanted with *Dolichos*, the Columbus grass died out. Later in the season, the *Dolichos* itself died out, and the area was overrun with weeds. During the heavy rains in October and November, the Columbus grass was heavily infected with a wide range of leaf diseases. Perennial Kavirondo sorghum was slow and uneven in establishment. It was very unproductive and had died out by July.

Fibres

Doum Palm Observations—Mtwapa

Fruits from different species of *Hyphaene* have been collected from Ethiopia and Kenya. Germination takes place in two to three months and is accelerated by soaking the fruit in hot water for 24 hours prior to planting. Leaf decortication has been carried out on Corona and raspidor machines. Fibre samples have proved acceptable as a partial substitute for jute in bag manufacture. The A.R.O. (Eng.) is developing a tractor-mounted raspidor for dry decortication.

Cattle

The Jersey herd at Mtwapa has been expanded to 35 cows and 26 young stock. During the year, five cows have died, two of these from "summer mastitis". Streptococcal mastitis has also been a serious factor resulting in

considerable losses of milk. By reverting to hand milking, the incidence of mastitis has now been reduced considerably. Nine cows have completed a lactation since the Jerseys were introduced to Mtwapa in 1960. The average lactation for these nine cows is 487.4 gallons. During the year, a pedigree bull calf was presented to the Station by Osirua Jerseys Ltd. This bull will be used in rotation with the four A.I. bulls now in use.

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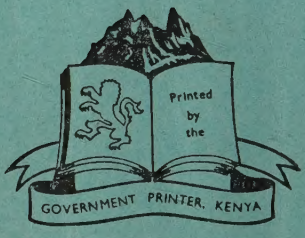
Agricultural Officer (*Research*).

G.P.K. 1662—730—6/62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